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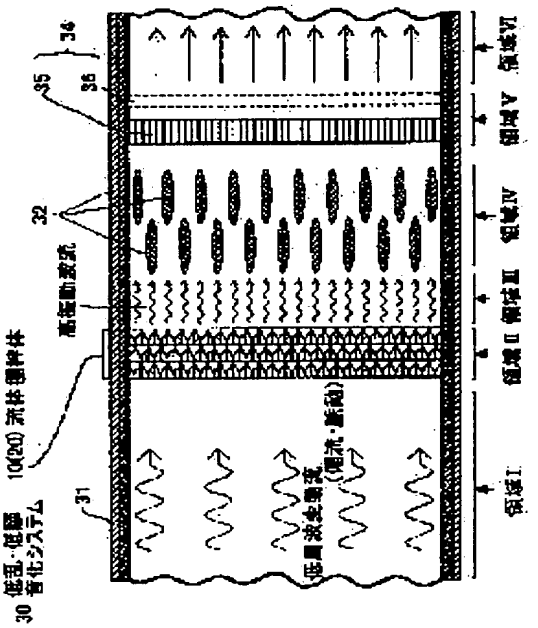
(54) FLUID STIRRER, AND DISTURBANCE AND NOISE REDUCTION SYSTEM FOR FLUID FLOW USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a disturbance and noise reduction system for a fluid flow that reduces the disturbance and noise by temporarily modulating noise and low-frequency-range components of an air current of wind tunnel test facilities, air-conditioning facilities, etc., into high-frequency components which are easy to attenuate.
SOLUTION: A fluid stirrer 10 provided in a wind channel is constituted by stacking fluid stirring layers 22, 23, and 22 formed by putting fine stirring elements, rotating (twisting) a fluid flow in the wind channel by fine flows, together in a honeycomb shape. A drift and a ripple as low-frequency components with long variation cycles included in a uniform flow are modulated into microvortexes of a high-frequency range which easily attenuate when passing through the fluid stirrer 10. Noise of high frequency is further attenuated by a sound absorber 33 as a noise reducing means arranged on the downstream side of the fluid stirrer 10. A straightening mechanism 34 composed of a honeycomb and a net for straightening can be provided on the downstream side of the sound absorber 33.



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* NOTICES *

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2.**** shows the word which can not be translated.
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CLAIMS

[Claim(s)]
[Claim 1] The fluid agitator body characterized by carrying out set arrangement and two or more minute stirring components which give a twist for every minute flow of flowing fluid changing a fluid channel.
[Claim 2] Said minute stirring component is a fluid agitator body according to claim 1 characterized by having the barrel arranged along said fluid flow direction, and the twist element which consists of the plate arranged and twisted in said barrel.
[Claim 3] Said barrel is a fluid agitator body according to claim 2 characterized by being tubed cels, such as a cylinder cel, a square cylinder cel, and a 6 rectangular-pipe cel.
[Claim 4] Said twist element is a fluid agitator body according to claim 2 or 3 characterized by being sheet metal twisted around the shaft which meets in the direction of axial flow at an angle of within the limits of 30 - 180 degrees.
[Claim 5] A fluid agitator body given in any 1 term of claims 2-4 characterized by forming in said sheet metal or said barrel the stoma which permits passage of said fluid.
[Claim 6] Said minute stirring component is a fluid agitator body given in any 1 term of claims 2-5 characterized by being the multiple-string stirring component by which said two or more twist elements connected the twist direction by turns, and have been arranged along the flow direction of said fluid inside said barrel.
[Claim 7] Said minute stirring component is a single stirring component which has arranged said one twist element inside said barrel. The fluid stirring layer formed by carrying out set arrangement of said single stirring component at the shape of a field carries out the twist direction of said twist element of said minute stirring component which stands in a row along the flow direction of said fluid by turns. A fluid agitator body given in any 1 term of claims 2-5 characterized by carrying out the ****** configuration in two or more step product.
[Claim 8] Said minute stirring component is a fluid agitator body according to claim 1 characterized by connecting the edge train located in a line with the lengthwise direction or longitudinal direction of said twist element which was formed in tabular [which was twisted], and which twisted, is an element, arranged the twist direction, arranged in all directions, and has been arranged in the shape of flat-tapped with the common girder.
[Claim 9] Said twist element and said girder are a fluid agitator body according to claim 8 characterized by being fabricated in one by sintering of a ceramic ingredient, or vacuum sintering of a resin ingredient.
[Claim 10] Low ** and the low noise-ized system of the fluid flow which consists of consisting of applying said fluid agitator body of a publication to any 1 term of claims 1-9 to said flow accompanied by turbulence or the noise.
[Claim 11] low ** and the low noise-ized system of the fluid flow according to claim 10 which consists of the noise-reduction means being arranged in the back-wash side of said fluid agitator body in said fluid channel.
[Claim 12] Said noise-reduction means is low ** and the low noise-ized system of the fluid flow according to claim 11 characterized by being the absorption-of-sound wall which constitutes a part of wall surface of said fluid channel, or the acoustical panel prepared in the wall surface of said fluid channel.
[Claim 13] Said noise-reduction means is low ** and the low noise-ized system of the fluid flow according to claim 11 characterized by being an active noise-control means to generate the sound of an opposite phase to the sound generated from said fluid which passed said fluid agitator body.
[Claim 14] Low ** and the low noise-ized system of fluid flow given in any 1 term of claims 11-13 which change from the rectification device which rectification-izes flow of said fluid being arranged to the back

wash of said noise-reduction means.
[Claim 15] Low ** and the low noise-ized system of fluid flow given in any 1 term of claims 10-14 characterized by being applied to a wind tunnel experiment facility by arranging said fluid agitator body on the set drum which constitutes said a part of fluid channel.
[Claim 16] Low ** and the low noise-ized system of fluid flow given in any 1 term of claims 10-14 characterized by being applied to a HVAC system by arranging said fluid agitator body to ventilation opening by the side of the interior of a room, or the blast area by the side of outdoor.
[Claim 17] Low ** and the low noise-ized system of fluid flow given in any 1 term of claims 10-14 characterized by being applied to important point cooling electronic equipment, such as a personal computer and a measuring machine machine, by including in the exhaust port of arranging said fluid agitator body for the exhaust port of a cooling fan in which it is prepared for heat discharge, or said cooling fan.
[Claim 18] Said fluid agitator body is low ** and the low noise-ized system of fluid flow given in any 1 term of the claim terms 10-14 which consist of being applied to path road-side walls, such as a highway.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to an applicable fluid agitator body, and low ** and the low noise-ized system which used that fluid agitator body to a device and a facility with the fluid flow accompanied by turbulence and the noise of path road-side walls, such as a wind tunnel experiment facility, air-conditioning and ventilating facilities, a device that has a fan for air cooling, and a highway, etc.
[0002]
[Description of the Prior Art] The conventional, for example, wind tunnel experiment, facility is developed with the history of aircraft development, and the various wind tunnel experiment facilities corresponding to the fluid rate from a low speed to a hypersonic region are developed in current. While it is not only used in the aircraft field, but use expands a wind tunnel experiment facility to the field of other industries, such as an automobile, a bridge, construction, and an environment, in development of rotorcrafts, such as a fixed-wing aircraft and a HEL, for the purpose of grasp of aerodynamic characteristics, the elucidation of the transition to a turbulent flow from a laminar flow, research of the cure against the noise, etc., improvement in the air-current property acquired is desired about the wind tunnel experiment facility itself.
[0003] It sets in the researches-and-developments field of the aircraft with diversification of such a use technique of a wind tunnel experiment facility in recent years. The transition mechanism on the airframes (fuselage, main plane, etc.) front face towards improvement in aerodynamic characteristics, In order to call for the test facility which fills the engine performance required to solve various phenomenon mechanisms, such as the Rota noise generating mechanism of a HEL, and to realize such a test facility Low ** and the low noise-ized technique about reduction-izing of the turbulence and the noise of a wind tunnel air current are indispensable. Generally the wind tunnel experiment facility of a cycloid type consists of a blower (axial flow fan), a diffuser (the 1- the 3rd), a flection (the 1- the 4th), the middle cylinder, a set drum (a rectification honeycomb and network), a contracted-vein drum, a test section, etc.
[0004] Moreover, recently, the environmental cure to the low frequency noise generated from large-sized air-conditioning, the exhaust air facility, etc. used for a skyscraper or a large-sized plant facility is becoming important. That is, in large-sized air-conditioning and an exhaust air facility, like the wind tunnel facility, the noise is emitted outside from the fan, and especially about the low frequency noise, it has been a problem noting that it has had harmful effects of stress etc. on human being, livestock, etc. which are in the perimeter of a blower or a fan.
[0005] In order to form the fan style in a wind tunnel experiment facility of a cycloid type etc., air-conditioning, ventilating facilities, etc. into low ** and the low noise, each functional facility of a rectifier, an absorption-of-sound wall, etc. is required. (1) There are a simple substance method by the large-sized axial flow fan with which high dynamic pressure and quantity airflow are obtained, and a compound method which bundled two or more small axial flow fans low dynamic pressure and for low airflow in the fan equipment who generates an air current. In order to fill these demands in both methods, various cures are taken conventionally. namely, as a ****** technique of the air current of the wind tunnel experiment facility by the large-sized fan method Turbulence of the air current by the big revolution style (channeling and pulsating flow) produced in an air course by the fan Thin mesh-ization of the screen (wire gauze) which makes small extension of a rectification cascade (corner cascade), increase of thickness of a honeycomb (parallel honeycomb), and turbulence rectifies, and how to secure a fixed air-current distribution (rate, pressure, and turbulence) property by extracting flow on a contracted-vein drum further is considered. In the case of a compound fan method, there is a property that the revolution style generated for every fan interferes each other with each other, and turns into small channeling and pulsating flow, the effectiveness

of a cascade, a grid, and a screen is large, and although the small air-current distribution (rate and pressure) property of turbulence is easy to be acquired, as a wind tunnel facility, effectiveness is bad. As a low noise-ized technique of the noise generated from fan style Xia (fault of a wind) generated by the revolution style by the large-sized fan method, the structure (a cascade and wall), etc., there is a technique of the passive method by extension of the absorption-of-sound wall which absorbs the noise in an air course, and an acoustical panel, the increase of thickness, etc.

[0006] (2) There is the approach of making it into the structure separated for every element structure as a reduction technique of the mechanical oscillation generated from each structure of a wind tunnel. Moreover, there is an active noise-control method using the microphone and the loudspeaker as a technique effective in reduction of the noise of (3) high frequency bands. By catching the noise with a microphone, making the wavelength sound of the opposite phase doubled with noise wavelength on real time, and turning and taking out the wavelength sound of the opposite phase to a sound source, the noise is negated mutually and an active noise-control method reduces it.

[0007]

[Problem(s) to be Solved by the Invention] However, there are the following troubles about techniques, such as arrangement of (1) corner cascade, a rectification honeycomb, a network, and an acoustical panel. That is, number-of-sheets extension of a corner cascade causes decline in blower effectiveness by the reaction which increases, so that number of sheets is increased. Moreover, although it is making the throat area ratio of a core small and increasing the thickness of a core about a rectification honeycomb and the rectification effectiveness of a high frequency band is remarkable, effectiveness is small in order that a pressure wave may tend to pass a honeycomb to the fluctuation style of a low frequency band. Although turbulence can be made small if the throat area ratio of a network is made small, reaction with the network to fluid flow becomes large, consequently decline in blower effectiveness and aggravation of the distribution property by blinding are caused, and the still still bigger effectiveness about the fluctuation style of a low frequency band is not acquired. furthermore , although installation of the acoustical panel which consist of a perforated plate , a glass wool mat , etc. be effective in the noise in the broadband from low frequency to a RF , attenuation in case the acoustic wave which passed the hole reflect each other between panels be only use , the long installation space doubled with the thickness of the panel set by make it function effectively at wavelength and the period of wavelength be needed , and enlargement pose a problem in respect of the diameter and the die length of an air course .

[0008] (2) About vibration generated from the structures within an air course, such as a blower and a corner cascade, although effect on a test section can be made small by considering as the structure separated to each element structure (a blower, ******, a test section, diffusion drum) of every, when having followed turbulence and the noise on the fluid flow itself, sufficient correspondence cannot be performed.

(3) If the technique of an active noise-control method is within the limits of the frequency characteristics (several Hz or more) of a loudspeaker in the small facility with small airflow, even if it will apply it, it is effective, but about a wind tunnel experiment facility, and large-sized air-conditioning and a plant facility, since huge energy is needed for acquiring expected effectiveness even if applicable about especially the pulsating flow of a low frequency band several Hz or less, it is not practical.

[0009] However, generally, although the damping effect by the distance [noise / of a high frequency band] through air is greatly easy for reduction-izing among ventilation and an exhaust air air current, each above-mentioned rectification means or an above-mentioned absorption-of-sound means cannot be reduced, so that the correspondence to the low frequency (low oscillatory wave) noise with the long period of vibration can satisfy enough turbulence and the noise. [in / it is difficult and / a low frequency band] It becomes important to establish both the techniques of ****** of air-current turbulence and the reduction in the noise of the noise as a wind tunnel facility which can respond to the newest research level.

[0010] Then, like a wind tunnel experiment facility, and large-sized air-conditioning and a plant facility, when the flow of the fluid accompanied by the turbulence and the noise of a low frequency band by a large-sized blower fan and a large-sized ventilating fan, or the compound fan exists, it sets. The technical problem which should be solved in that low ** and low noise-ization are attained occurs under the new way of thinking by making the micro vortex accompanied by turbulence of the RF (high oscillatory wave) whichis [reduction-] easy toize once modulate pulsating channeling which is a low-frequency component with a long fluctuation period.

[0011] The purpose of this invention is offering the fluid agitator body which can reduction-ize to coincidence the low frequency fluctuation style component (channeling and pulsating flow by the fan) which exists in the fluid flow in path road-side walls, such as a wind tunnel experiment facility of a cycloid

type etc., an air conditioner, a large-sized plant, and a highway, etc., and the low-frequency component of the noise, and low ** and the low noise-ized system which used that fluid agitator body.
[0012]
[Means for Solving the Problem] In order to solve the above-mentioned technical problem, the fluid agitator body by this invention is characterized by carrying out set arrangement and constituting two or more minute stirring components which give a twist for every minute flow of flowing fluid in the fluid channel.
[0013] Since set arrangement of two or more minute stirring components is carried out, when according to this fluid agitator body the uniform fluid flow accompanied by big channeling and pulsation of a low frequency band flows a fluid channel and passes a fluid agitator body, a minute stirring component gives a twist for every minute flow of a fluid, consequently channeling and pulsation of a low frequency band are modulated for it by the micro vortex of a fixed high frequency band. Moreover, about the noise by which a fluid is accompanied, a high frequency component becomes irregular according to a twist operation of a minute stirring component like [component / dynamic pressure] channeling and pulsation, and it decreases by interference produced by the repeat of reflection in a minute stirring component front face about a static pressure component like a compressional wave, or is too changed into a high frequency component by the modulation. As compared with the component of a low frequency band, it is easy to muffle, and the micro vortex and noise which consist of a high-frequency component serve as flow of low ** and the low noise enough, after passing a fluid agitator body, attenuation and. Therefore, according to this invention, the subsonic vibration component (channeling and pulsating flow) and low frequency noise of a fan style are reduced by coincidence.
[0014] In this fluid agitator body, said minute stirring component can have the barrel arranged along said fluid flow direction, and the twist element which consists of the plate arranged and twisted in said barrel. the material of a configuration with both easy barrels and plates -- it is -- processing -- easy -- a barrel -- twisting -- the combination of a plate -- a minute stirring component -- easy structure -- and manufacturing in large quantities is possible. Especially about the noise which flow has, it is reflecting in the direction which the compressional wave of a sound twists, originates in the configuration of an element, and intersects flow intricately, and decreases effectively.
[0015] Said barrel can be used as tubed cels, such as a cylinder cel, a square cylinder cel, and a 6 rectangular-pipe cel, in the minute stirring component which has the above-mentioned twist element. By using the configuration of a barrel as tubed cels, such as a cylinder cel and an rectangular pipe cel, it becomes possible to give a twist for every minute fluid which the fluid agitator body which gathered two or more minute stirring components to crowding with a high consistency was obtained, divided the fluid into minute flow efficiently, and was divided about most or all the parts of fluid flow. Moreover, said twist element can consist of sheet metal twisted around the shaft which meets in the direction of axial flow at an angle of within the limits of 30 - 180 degrees. Generation of the micro vortex from which whenever [torsion-angle] changes the fluctuation component of a low frequency band into the fluctuation component of a high frequency band at less than 30 degrees is small, and cannot expect efficient attenuation with turbulence and the noise. If whenever [torsion-angle] exceeds 180 degrees, the big turbulence on the contrary with flow will be produced, and since reaction also increases, efficient attenuation with turbulence and the noise is not expectable too. Furthermore, by forming in said sheet metal or barrel the stoma which permits passage of said fluid, passage of a stoma of a fluid is attained, it is urged to formation of a finer minute eddy, and turbulence and the noise are reduced further.
[0016] Said minute stirring component can be used as the multiple-string stirring component which said two or more twist elements connected the twist direction by turns along the flow direction of said fluid, and has been arranged inside said barrel in the fluid agitator body which has the above-mentioned twist element. The fluid flow accompanied by a changed part and the noise of low frequency is changed into much more high frequency component according to the continuous stirring operation in each twist element, and becomes easier to decrease fluctuation and the noise by [which changed the twist direction on either side] twisting and piling up an element by turns in a cylinder.
[0017] In the fluid agitator body which has the above-mentioned twist element, said minute stirring component is a single stirring component which has arranged said one twist element inside said barrel. Said fluid agitator body The twist direction of said twist element of said minute stirring component which stands in a row the fluid stirring layer which the shape of a field was made to carry out set arrangement, and formed said single stirring component in it along the flow direction of said fluid can be carried out by turns, and it can constitute from ****** in two or more step product. By laying a fluid stirring layer on top of the condition of seeing in one minute fluid flow direction, and changing the twist direction of the minute stirring

component of each fluid stirring layer alternately with right and left when the laminating of two or more fluid stirring layers is carried out, by turns The fluid flow accompanied by a changed part and the noise of low frequency is changed into much more high frequency component according to the continuous stirring operation by the minute stirring component of each fluid stirring layer which overlaps two or more steps, and becomes easier to decrease fluctuation and the noise. In addition, about the method of the laminating of each fluid stirring layer, a laminating may be changed into the condition that change the laminating into the condition that the minute molten-bath stirring component of each class aligned correctly in the fluid flow direction, and the minute molten-bath stirring component of each class aligned alternately in the fluid flow direction.

[0018] In the fluid agitator body by this invention, said minute stirring component can connect the edge train located in a line with the lengthwise direction or longitudinal direction of said twist [which was formed in tabular / which was twisted] element which it twists, is an element, arranged the twist direction, arranged in all directions, and has been arranged in the shape of flat-tapped with a common girder, and can constitute it. According to this fluid agitator body, the edge which was formed in tabular [which was twisted] and which twists and serves as an entrance side to the fluid flow of an element serves as an edge train located in a line in the direction in every direction of either in the shape of flat-tapped, and is connected with the common girder. Moreover, the edge which serves as an outlet side to fluid flow also serves as an edge train located in a line in the direction of another side in every direction in the shape of flat-tapped, and it connects with the common girder. Therefore, the aggregate of a twist element is unified in the train of the girder of length or width by both sides, and it becomes possible to deal with many twist elements as one rigid high goods.

[0019] The both ends of the above-mentioned twist element can fabricate said twist element and said girder in one by sintering of a ceramic ingredient, or vacuum sintering of a resin ingredient in the fluid agitator body connected with the girder. It is possible to carry out die forming easily also with the fluid agitator body which can use for example, the Mitsuzo form technique and has a complicated configuration by fabricating by sintering or vacuum sintering.

[0020] Low ** and the low noise-ized system of fluid flow can consist of applying the above-mentioned fluid agitator body to said flow accompanied by turbulence or the noise. It is possible to attain low ** and low noise-ization by the modulation operation to the high frequency band of a fluid agitator body and noise attenuation by following turbulence and the noise for the inside of a fluid channel on flowing fluid by various causes, and arranging a fluid agitator body in a fluid channel in such a case.

[0021] a noise-reduction means can be arranged in the back-wash side of said fluid agitator body of said fluid channel in low ** and the low noise-ized system of this fluid flow. By arranging a noise-reduction means, the noise of a high frequency component is further muffled much more efficiently by the noise-reduction means. As for said noise-reduction means, it is desirable to consider as the absorption-of-sound wall which constitutes a part of wall surface of said fluid channel, or the acoustical panel prepared in the wall surface of said fluid channel. Since the noise of the high frequency band which channeling and the pulsation changed into the micro vortex of a high frequency band by passing a fluid agitator body generate becomes that it is easy to be absorbed with the acoustical panel arranged by the back wash of a fluid agitator body effectively, low noise-ization of flow is advanced further.

[0022] In low ** and the low noise-ized system of this fluid flow, said noise-reduction means can be considered as an active noise-control means to generate the sound of an opposite phase to the sound generated from said fluid which passed said fluid agitator body. An active noise control is the technique of denying the sound of a sound source and aiming at silence by making a sound source turn and generate from a loudspeaker the acoustic wave of a sound source and the acoustic wave of an opposite phase which were caught with the microphone. The noise changed into the high frequency band with the fluid agitator body applies the active noise-control means which is effectiveness and it is supposed that it is to the sound of the component of the high frequency band which is the frequency characteristics (several Hz or more) which are the conventional loudspeakers, and the noise of a low frequency band is reduced.

[0023] In this low ** and low noise-ized system, the rectification device which rectification-izes flow of said fluid can be arranged in the back wash of said noise-reduction means. The stable fluid flow is acquired further further by being easy to decrease channeling and the pulsation changed into the high frequency band, and arranging the rectification device constituted from an parallel honeycomb, a network, etc. by the back wash of a noise-reduction means, although it is suitable for practical use even when it remains as it is.

[0024] Low ** and the low noise-ized system of this fluid flow can be applied to the device and facility incorporating a blower with the fan who produces said fluid flow, a fan, and them, and a subsonic vibration component (channeling and pulsating flow) and a low frequency noise are reduced by coincidence about the

fan style to which low ** and a low noise-ized system were applied such. Low ** and a low noise-ized system are applicable to a wind tunnel experiment facility by arranging a fluid agitator body as the example on the set drum which constitutes said a part of fluid channel. Moreover, low ** and the low noise-ized system of fluid flow are also applicable to a HVAC system by arranging said fluid agitator body to ventilation opening by the side of the interior of a room, or the blast area by the side of outdoor. Moreover, low ** and the low noise-ized system of fluid flow are applicable also to important point cooling electronic equipment, such as a personal computer and a measuring machine machine, by including in the exhaust port of arranging said fluid agitator body for the exhaust port of a cooling fan in which it is prepared for heat discharge, or said cooling fan. Furthermore, said fluid agitator body is also applicable to path road-side walls, such as a highway, paying attention to a noise-reduction operation.

[0025]

[Embodiment of the Invention] Hereafter, with reference to an accompanying drawing, the example of the fluid agitator body by this invention and the example by which the fluid agitator body concerned was applied to the wind tunnel experiment facility as low ** and a low noise-ized system of fluid flow, the exhaust air facility, etc. are explained to a detail. First, the configuration of the fluid agitator body using a minute stirring component etc. is explained. Drawing 1 (a) - drawing 1 (c) are the perspective views showing the example of the twist element of the minute stirring component which constitutes the fluid agitator body of the fluid flow by this invention.

[0026] Minute stirring component 1a shown in drawing 1 (a) is the single stirring component equipped with cylinder cel 4a as a barrel which twisted and formed the sheet metal material in the surroundings of the element axis 3 and which twists and holds element 2L and twist element 2L in the interior. In the example of drawing 1 (a), twist element 2L is a left twist element which looks at the minute fluid flow which flowed to the flow direction, and is twisted on the left. Left twist element 2L is the configuration which bisects the cross section of cylinder cel 4a in every cross section which includes the input and the tap hole of a fluid for cylinder object 4a. Minute stirring component 1b shown in drawing 1 (b) is equipped with left twist element 2L which twists on the left the minute fluid which is twisted and formed in the surroundings of the element axis 3, and passes a sheet metal material, and the rectangular pipe cel as a barrel which holds left twist element 2L in the interior. An rectangular pipe cel is hexagon-head cylinder cel 4b in this example. Left twist element 2L is dividing hexagon-head cylinder cel 4b into two at an inlet port and an outlet. In addition, you may have the right twist element which it not only twists the minute fluid to pass on the left, but twists it on the right as a single stirring component.

[0027] Drawing 1 (c) shows minute stirring component 1c as a multiple-string stirring component which detached only spacing e and formed successively left twist element 2L and right twist element 2R along with the element axis 3 in [of one] long cylinder cel 4c. Minute fluid flow which flowed in cylinder cel 4c receives rotation of the direction returned by right twist element 2R, after being ******(ed) by left twist element 2L. Although whenever [between the entrance side of each twist elements 2L and 2R and an outlet side / relative torsion angle] is made into 90 degrees in the example shown in drawing 1 (a) - drawing 1 (c), whenever [this relative torsion angle] should just be range which is 30 - 180 degrees which can generate a micro vortex efficiently, without restricting to 90 degrees. At less than 30 degrees, generating of a micro vortex has whenever [too little / relative torsion angle], and when whenever [relative torsion angle] exceeds 180 degrees, turbulence occurs with flow on the contrary.

[0028] About the principle of fluid stirring, the outline is explained based on drawing 1 (c). The revolution style (channeling and pulsating flow) produced by the fan (it mentions later) turns into 2 division vortexes Sl and Sr on either side by the tap hole side of a left twist element 2L posterior part, becoming the flow St and Sb carried out 2 ****s up and down, and rotating by left twist element 2L, in the input of the first step of cylinder cel 4c. Next, the right-and-left 2 division vortexes Sl and Sr flow into right twist element 2R of the lower stream of a river established in the second step, are carried out 2 more ****s, in the posterior part of right twist element 2R, turn into the small quadrisection vortex (micro vortex) Smv, and become the flow which has a high fluctuation style (pressure fluctuation and noise) component.

[0029] Moreover, each elements 2L and 2R are carried out that it is easy to make it decrease about the noise made with fluid flow in modulating a high frequency component like channeling or a pulsating flow about a dynamic pressure component, are ****** which repeat complicated reflection on the front face of each REMENTO 2L and 2R about a static pressure part like a compressional wave, and have the operation which you make decrease or makes it change into a high frequency component. Since fluid agitator bodys gather, and are constituted, where the crossing cross section which crosses a fluid channel is crossed and covered so that the axis of the barrel may meet fluid flow in a minute stirring component and the micro vortex Smv

occurs over the whole region of a fluid agitator body so that it may mention later, the turbulence and the noise of a low frequency band which have produced the air current in an air course cross section in the uniform flow are modulated by the high frequency component.

[0030] Drawing 2 is the perspective view showing the example which formed in the twist element or the barrel the hole which permits passage of a fluid. Left twist element 2L by which the hole 5 of a large number which permit passage of a fluid was formed in drawing 2 (a) and drawing 2 (b), respectively, and right twist element 2R are shown. The hole 6 of a large number which permit passage of a fluid is formed in hexagon-head cylinder cel 4b shown in drawing 2 (c). The same is said of the case of cylinder cel 4a as a barrel shows to drawing 1 (a).

[0031] Drawing 3 is drawing showing an example of the fluid agitator body which constituted it combining many minute stirring components shown in drawing 1 in order to change the fluid flow accompanied by low frequency into flow with a high frequency component, and it is the A-A sectional view of the fluid agitator body which shows drawing 3 (a) in the front view of the fluid agitator body, and shows drawing 3 (b) to drawing 3 (a). The fluid agitator body 10 shown in drawing 3 gathers to juxtaposition 1d of many minute stirring components which form successively two or more right-and-left twist elements 2L and 2R by turns, and change along the flow direction of the fluid within the cel in [of one] cylinder cel 4a, and is constituted. In the example of drawing, since the path (it is an air course when a gas like air flows) where a fluid flows is a cross-section hexagon, the cross section of an air course can be fill uped with making into the shape of 6 in all square shapes the appearance of the fluid agitator body 10 which gathered 1d of many minute stirring components at the cross-section configuration. The twist pattern with which the number of the elements formed successively in one barrel is three, therefore a fluid is twisted has two types like 2L, 2R, 2L, or 2R, 2L and 2R. Moreover, the twist pattern of a twist element is made reverse in the set section of 1d of minute stirring components in the upper half of drawing, and the set section of 1d of minute stirring components in the lower half of drawing. The whole gathers 1d of many minute stirring components in a hexagon-head-like band or a frame 11, and the fluid agitator body 10 is incorporated in the shape of a honeycomb.

[0032] Drawing 4 is drawing showing another example of the fluid agitator body constituted combining many minute stirring components shown in drawing 1 , and it is the B-B sectional view of the fluid agitator body which shows drawing 4 (a) in the front view of the fluid agitator body, and shows drawing 4 (b) to drawing 4 (a). The fluid agitator body 20 shown in drawing 4 carries out the laminating of the fluid stirring layers 22 and 23 which gathered much minute stirring component 1c which incorporated either a left twist element or the right twist elements 2L and 2R in hexagon-head cylinder cel 4a as shown in drawing 1 (b) to two or more steps, and is constituted. By setting a barrel to hexagon-head cylinder cel 4a, the cross section of an air course can be filled completely. The whole gathers much minute stirring component 1c in a hexagon-head-like band or a frame 21, and each fluid stirring layers 22 and 23 are incorporated in the shape of a honeycomb. In the example of illustration, in step [1st] - the 3rd step, the laminating of the fluid stirring layers 22, 23, and 22 is carried out to three steps, respectively, and each fluid stirring layers 22 and 23 are with the set section in the upper half of drawing, and the set section of a lower half, and have changed the twist pattern of a twist element. However, it twists, and like the example which was seen in the flow direction of a fluid and which is shown in drawing 3 , the pattern is set up by turns like 2L, 2R, 2L, or 2R, 2L and 2R, and is made into the configuration where the whole profile configuration was also doubled with the configuration (cross-section hexagon) of a fluid channel.

[0033] When carrying out the laminating of the fluid stirring layers 22 and 23 shown in drawing 4 to a multistage format, as shown in drawing 5 , the mode which carries out a laminating can be chosen in an adjacent fluid stirring layer. Drawing 5 R> 5 (a) is the sectional view showing the coaxial arrangement mode which aligned each minute stirring component from which the twist direction differs in the fluid stirring layers 21 and 22 which keep their distance e1 and adjoin each other on the same axle, for example, minute left stirring component 1L of the downstream is arranged at the condition of having placed the axis of a mutual barrel on the same axle, to minute right stirring component 1R of the fluid stirring layer 21 of the upstream. the fluid which flowed into minute right stirring component 1R of the upstream flows into minute left stirring component 1L of the downstream which aligned as it is ideally, and mixed stirring of the flow divided by right twist element 2of minute right stirring component 1R of the upstream R is carried out by left twist element 2of minute left stirring component 1L by the side of back wash L. Moreover, drawing 5 (b) is the sectional view showing the alternate arrangement mode which was able to shift alternately each minute stirring components 1R and 1L from which the twist direction differs in the fluid stirring layers 21 and 22 which keep their distance e2 and adjoin each other, for example, to minute right stirring component

1R of the fluid stirring layer 21 of the upstream, minute left stirring component 1L of the downstream can shift the axis of a mutual barrel alternately, and is arranged. The fluid which flowed into minute right stirring component 1R of the upstream is divided into two minute left stirring components 1L and 1L of the downstream which straddles alternately and continues, it flows and mixed stirring is carried out.
[0034] Drawing 6 is the perspective view showing another example of the fluid agitator body by this invention. The minute stirring component of the fluid agitator body 25 shown in drawing 6 is the twist element 26 formed in tabular, and two or more twist elements 26 (a sign is given only to a part) arrange the twist direction, put it in order in all directions, and are arranged in the shape of a grid. In the fluid agitator body 25, it is the horizontal edge [which was formed in tabular / which was twisted] train where the train of one edge 26a (for example, edge which serves as an entrance side to fluid flow) of an element 26 was located in a line with the longitudinal direction in the shape of flat-tapped by twisting, and each horizontal edge train is connected with the common cross girder plate 27 (27a, 27b, 27c ...) prolonged in the shape of [as the train / same] flat-tapped. Similarly, the train of other-end section 26b (for example, edge which serves as an outlet side to fluid flow) of the twist element 26 is the vertical edge train located in a line with the lengthwise direction in the shape of flat-tapped, and each vertical edge train is connected with the common stringer plate 28 (28a-28f ...) prolonged in the shape of [as the train / same] flat-tapped. On both sides, it is unified in the train of the girder located in a line in the direction different, respectively, i.e., the train of the cross girder plate 27 and the train of the stringer plate 28, and the fluid agitator body 25 as the aggregate of the twist element 26 can deal with many twist elements 26 as one rigid high goods in the activity of installation of the fluid agitator body 25, exchange, etc. Since it does not have the barrel surrounding the twist element 26, about the noise made with flow, the fluid agitator body 25 repeats the complicated reflection between elements 26, and decreases an acoustic wave much more effectively.
[0035] It faces manufacturing the fluid agitator body 25 with which the both ends 26a and 26b of the twist element 26 were connected in the train of the cross girder plate 27, and the train of the stringer plate 28, and the twist element 26 and each girders 27 and 28 can be fabricated in one by sintering of a ceramic ingredient, or vacuum sintering of a resin ingredient. By fabricating by sintering or vacuum sintering, the Mitsuzo form (RP) technique can be used and die forming can be easily carried out also with the fluid agitator body 25 which has a complicated configuration. When fabricating the fluid agitator body 25 with a ceramic ingredient, it can form in porosity easily and can be made lightweight, and further, since unification shaping of the entrance side and outlet side is carried out with the cross girder plate 27 and the stringer plate 28, respectively, the fluid agitator body 25 can form the shape of a grid as the whole, and can constitute it in high intensity.
[0036] Next, low ** and the whole low noise-ized system configuration of the fluid flow prepared in the air course are explained based on the publication of drawing 7 and drawing 8 . Drawing 7 is the sectional view showing the outline of low ** and low noise-ized SHITEMU by this invention equipped with the fluid agitator body and the noise-reduction means, and drawing 8 is a graph explaining the fluctuation physical quantity of the turbulence and **** in each field of low ** and low noise-ized SHITEMU shown in drawing 7 . Fundamentally, low ** and low noise-ized SHITEMU 30 arrange the fluid agitator body 10 (20 25) of a multilevel structure as shown in the air course wall 31 which has a hexagon-like path cross section at drawing 3 , drawing 4 , or drawing 6 , arranges the noise-reduction means 32 in the back wash of the fluid agitator body 10 (20 25), and is further constituted by arranging the rectification device 34 in the air course of the back wash of the noise-reduction means 32. The axial flow fan and compound fan of a blower or a fan are arranged in the upstream which is not illustrated, and it originates in this fan's operation, and is the big radical main stream of fluctuation where it was superimposed on the low frequency fluctuation style in which a ****** style appears the field I of an air course greatly to the uniform flow accompanied by [as shown in drawing 8 (a)] channeling and pulsation in flowing fluid flow, i.e., time amount progress.
[0037] In the fluid agitator body 10 (20 25) with which the flow by the fan was first prepared in Field II (oscillating modulation field) Go into each cel of the fluid stirring layer 22 constituted in the shape of [the 1st step of] a honeycomb, and 2 ****s is carried out. Next, it is further quadrisected in the fluid stirring layer 23 constituted in the shape of [the 2nd step of] a honeycomb, and it is further subdivided in the fluid stirring layer 22 constituted in the shape of [the 3rd step of] a honeycomb, an oscillating modulation is received, and it is changed into the uniform flow which has a micro vortex in Field III (steady-state vibration wave style field). As this uniform flow is shown in drawing 8 (b), the amount of flow fluctuation serves as only a component of a high frequency band. In the field IV (steady-state vibration wave mitigation field) which is the air course of the downstream, as a noise-reduction means 32, the acoustical panel 33 is formed in the air course wall 31, and absorbs the high frequency band component of a micro vortex. The

situation of the amount of flow fluctuation after turbulence and the noise of a high frequency band component were absorbed is shown in drawing 8 (c). In the field V of an after that style (rectification field), it is further rectified by the rectification device 34, and the uniform flow by which the high frequency band component was mitigation-ized turns into stable low ** and low noise style in Field VI (low ** and low noise style field). Specifically, the rectification device 34 consists of an parallel honeycomb 35 for rectification, and wire-screen 36 grade. Low ** and a low noise style are supplied to a test section, after considering as the flow further stabilized on the contracted-vein drum etc. after that.

[0038] The example which applied low ** and the low noise system of the fluid flow by this invention to the set drum of a wind tunnel experiment facility is shown in drawing 9 as a schematic diagram. The wind tunnel experiment facility 40 shown in drawing 9 is a wind tunnel facility of the cycloid type made to circulate through an air current by the fan 42 by whom a rotation drive is done with an electric motor 41. Though the flow from a fan 42 is spread, the 1st diffusion drum 43 which flows with big channeling and pulsation is formed in a fan's 42 back wash. One by one, the 1st flection 44, the middle drum 45, the 2nd flection 46, and the set drum 47 follow the back wash of the 1st diffusion drum 43, and low ** and the low noise system 30 by this invention equipped with the fluid agitator body 10 (20 25), the noise-reduction means 32, and the rectification device 34 (the parallel honeycomb 35 for rectification and wire screen 36) are applied to it in the set drum 47. The contracted vein of low ** and the low noise flow which flows by low ** and the low noise system 30 and by which the amount of fluctuation was mitigated is carried out on the contracted-vein drum 48, and it is sent to a test section 49. Since the flow by which turbulence and the noise were mitigated further is supplied to a test section 49, an accurate measurement result is expectable.

[0039] The example which applied low ** and the low noise system of the fluid flow by this invention to the 1st diffusion drum of a wind tunnel experiment facility is shown in drawing 10 as a schematic diagram. In structure equivalent to the structure of the wind tunnel experiment facility 40 shown in the wind tunnel experiment facility 50 shown in drawing 10 at drawing 9 , detailed explanation for the second time is omitted by attaching the same sign. Low ** and the low noise system 30 by this invention have arranged the fluid agitator body 10 (20 25) on the 1st diffusion drum 43 of a fan's 42 back wash, and arranges the noise-reduction means 32 and the rectification device 34 on the set drum 47 which passed through the 2nd flection 46. The contracted vein of low ** and the low noise flow which flows by low ** and the low noise system 30 and by which the amount of fluctuation was mitigated is carried out on the contracted-vein drum 48, and it is sent to a test section 49.

[0040] Drawing 11 is a schematic diagram in which low ** and the low noise system by this invention show the example applied to HVAC system 60. the fluid agitator body 10 (20 25) of the low ** and a low noise system according to this invention at the example of application shown in drawing 11 -- the interior of a room -- the air of 61 -- outdoor -- it is arranged in the blast area 66 of the duct 65 with which the fan 64 who drives by the motor 63 is formed in order to exhaust to 62. Although low ** and a low noise system consist only of the fluid agitator body 10 (20 25), since the noise of low frequency is changed into the noise of a high frequency band and the noise of a RF is quickly decreased after that according to a modulation operation of the fluid agitator body 10 (20 25), the exhaust air noise of a HVAC system can be suppressed as a result. Of course, if the allowances of a tooth space are in an outlet side, it is clear that the noise-reduction means 32 as shown in drawing 7 can be established. In addition, it is clear that a low noise system's [low ** and] it is also applicable to ventilation opening by the side of the interior of a room of HVAC system 60.

[0041] Drawing 12 is a schematic diagram in which low ** and the low noise system by this invention show the example applied to the air cooling fan of various kinds of metering devices 70. In the example of application shown in drawing 12 , an air cooling fan 71 is a formula with a built-in motor, and the fluid agitator body 10 (20 25) of low ** and a low noise system is formed in the outlet side of a bracket 73 which attaches an air cooling fan 71 in the equipment frame 72. It is possible to establish the noise-reduction means 32 as well as the example of application shown in drawing 11 . According to this example of application, it is mitigable that the accuracy of measurement of a metering device 70 is influenced with the noise of a cooling fan. Moreover, besides metering-device 70, in important point cooling electronic equipment like a personal computer, the fluid agitator body 10 (20 25) can be applied also to the outlet side of the empty cooling fan, can raise calm office nature, and can contribute it to an improvement of a work environment.

[0042]

[Effect of the Invention] Since set arrangement is carried out and two or more minute stirring components are constituted in the field which crosses a fluid channel as the fluid agitator body by this invention was

explained above When the uniform fluid flow accompanied by big channeling and pulsation of a low frequency band passes a fluid agitator body A minute stirring component gives a twist for every minute flow of a fluid, consequently the dynamic pressure component of big channeling and pulsation of a low frequency band, or the noise is once modulated for it by the micro vortex and noise of a fixed high frequency band (turbulence and noise). It is easy to decrease the micro vortex and noise which consist of a high-frequency component, and they are decreased quickly after passing a fluid agitator body. Moreover, the static pressure component of the noise becomes that it is easy to decrease by reflection in the front face of a minute stirring component. Therefore, according to this invention, the subsonic vibration component (channeling and pulsating flow) and low frequency noise of a fan style can be reduced to coincidence.

[0043] This invention can apply a wind tunnel facility, an air conditioner, etc. to the various facilities about the flow made into representation, and can constitute the above-mentioned fluid agitator body as low ** and a low noise system. That is, by applying the above-mentioned fluid agitator body to a wind tunnel facility, turbulence and the noise of the air current in a test section can be reduced effectively, and a highly precise measurement result is obtained in the field of researches and developments, such as researches and developments of airframes, such as an aircraft, transit bodies, such as an automobile, and a building. Moreover, the system which applied the above-mentioned fluid agitator body to large-sized air-conditioning and the exhaust air facility use for a skyscraper or a large-sized plant facility can reduce the low frequency noise generate from these large-sized air-conditioning, an exhaust air facility, etc., and can serve as an effective means also as an environmental cure which mitigates the low frequency noise which has harmful effects of stress etc. on human being who is in the perimeter of fans, such as a blower and a fan, livestock, etc. Moreover, if it applies to path road-side walls, such as a highway, when the pressure wave of the noise tends to pass a fluid agitator body, it decreases greatly by reflecting in the upper and lower sides and right and left intricately especially with a twist element.

[0044] As an example of application of others of the fluid agitator body by this invention, the following low ** and low noise system can be mentioned. namely, silence of ** blowdown tunnel -- if it prepares in a column, a low frequency noise is cancelable with a small facility. ** It can prepare in emission opening of the air cooling fan of a metering device, and the indoor noise can be reduced. ** an airport -- if it prepares in a sound-proof wall like the exhaust gas inhalation-of-air sound-proof wall (exhaust gas absorption opening) of the engine test facility to kick, the mitigation effectiveness of the noise and effect of exhaust gas recirculation can be made small.

[Translation done.]

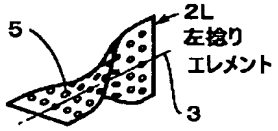
* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

[Drawing 2]

(a)



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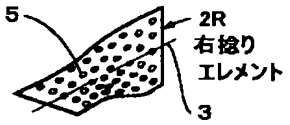

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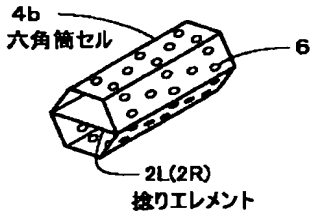
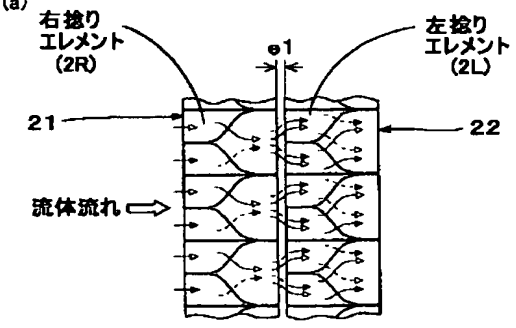


[Drawing 5]

(a)



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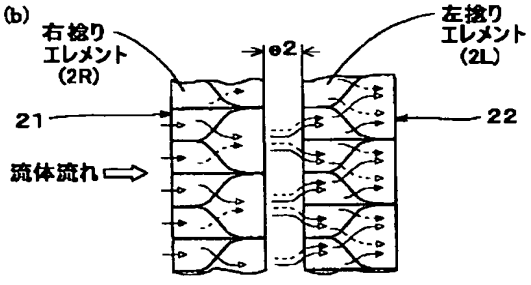
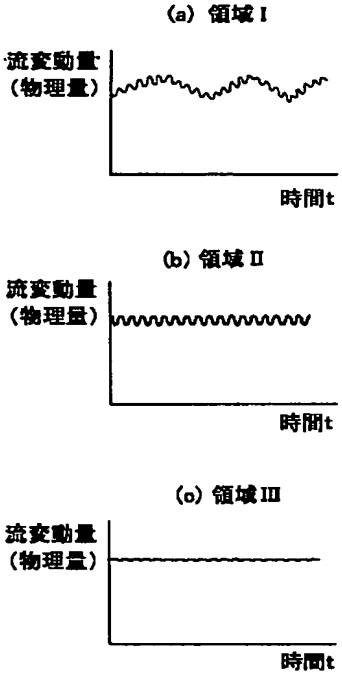
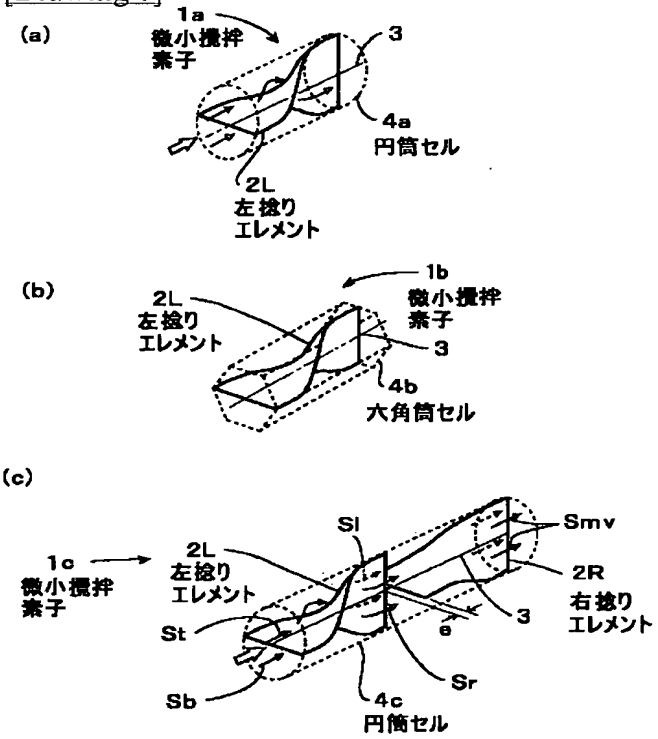


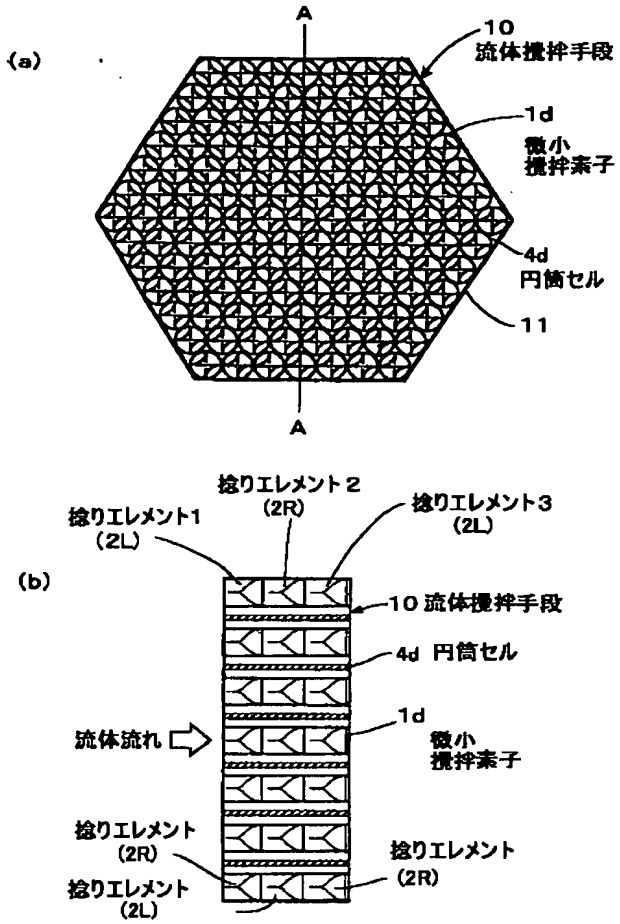
[Drawing 8]



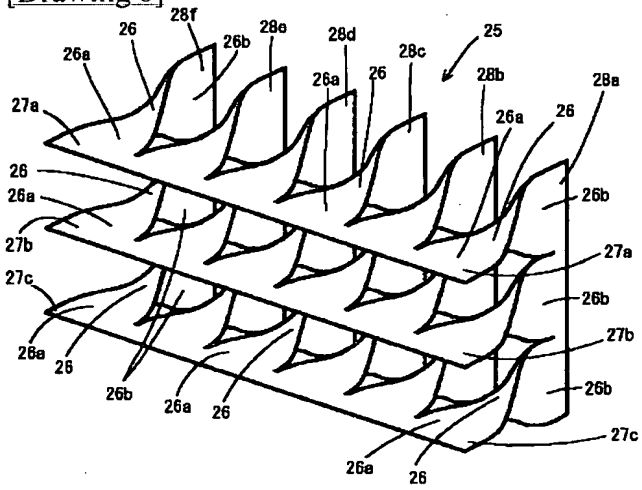
[Drawing 1]



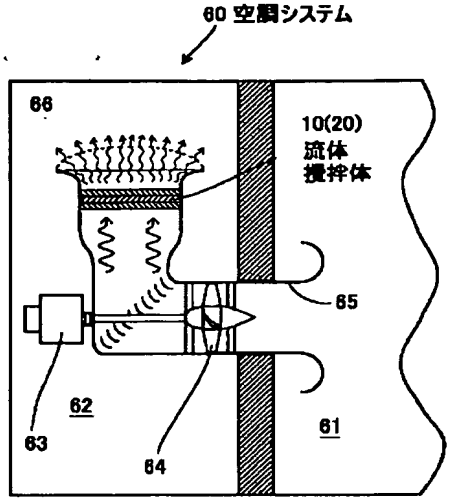
[Drawing 3]



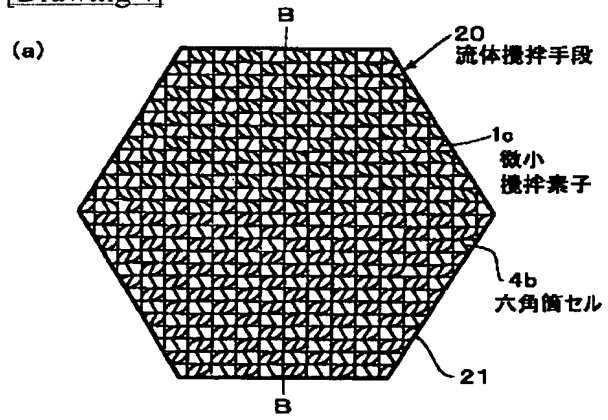
[Drawing 6]

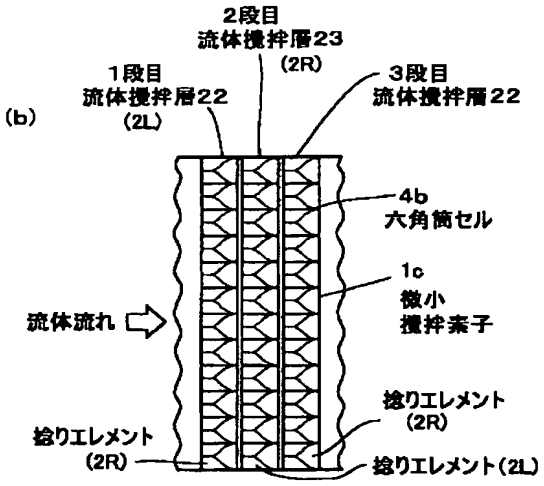


[Drawing 11]

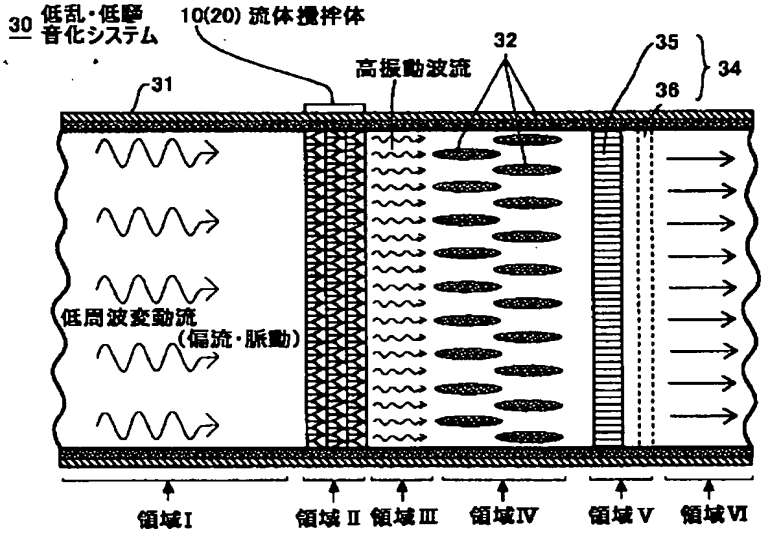


[Drawing 4]

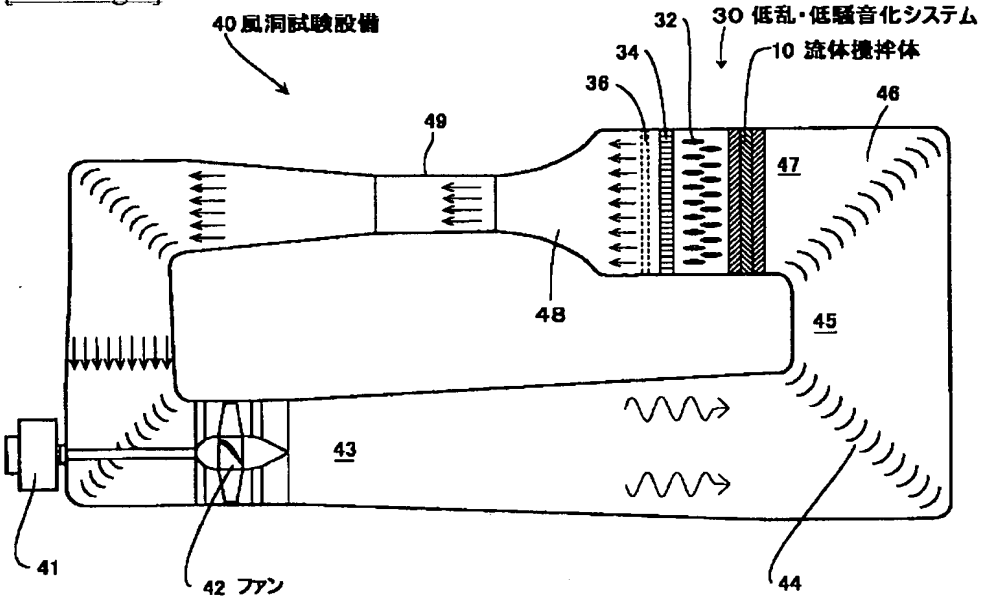




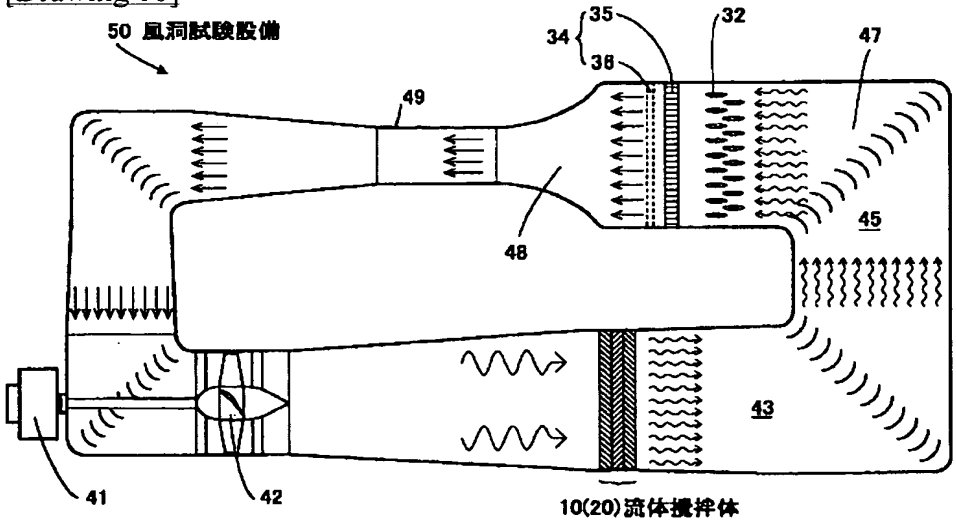
[Drawing 7]



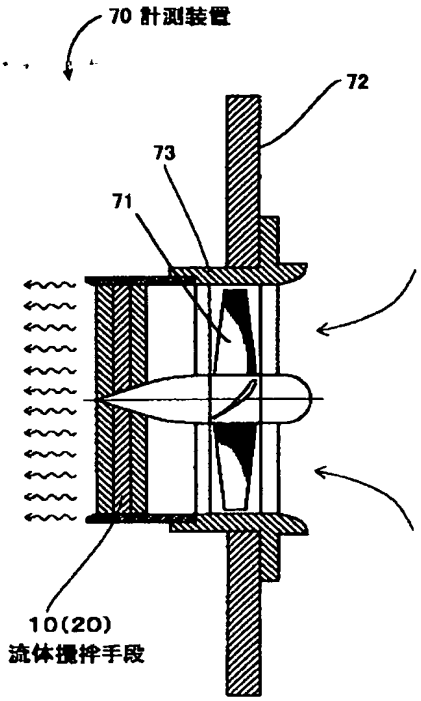
[Drawing 9]



[Drawing 10]



[Drawing 12]



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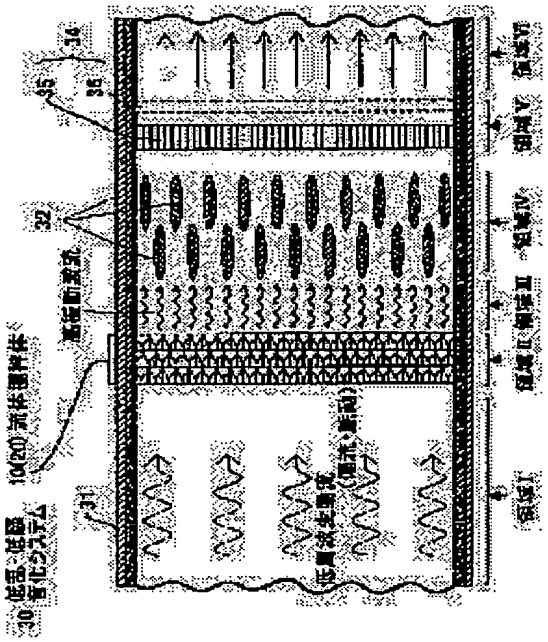
(54) FLUID STIRRER, AND DISTURBANCE AND NOISE REDUCTION SYSTEM FOR FLUID FLOW USING THE SAME

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a disturbance and noise reduction system for a fluid flow that reduces the disturbance and noise by temporarily modulating noise and low-frequency-range components of an air current of wind tunnel test facilities, air-conditioning facilities, etc., into high-frequency components which are easy to attenuate.
SOLUTION: A fluid stirrer 10 provided in a wind channel is constituted by stacking fluid stirring layers 22, 23, and 22 formed by putting fine stirring elements, rotating (twisting) a fluid flow in the wind channel by fine flows, together in a honeycomb shape. A drift and a ripple as low-frequency components with long variation cycles included in a uniform flow are modulated into microvortexes of a high-frequency range which easily attenuate when passing through the fluid stirrer 10. Noise of high frequency is further attenuated by a sound absorber 33 as a noise reducing means arranged on the downstream side of the fluid stirrer 10. A straightening mechanism 34 composed of a honeycomb and a net for straightening can be provided on the downstream side of the sound absorber 33.



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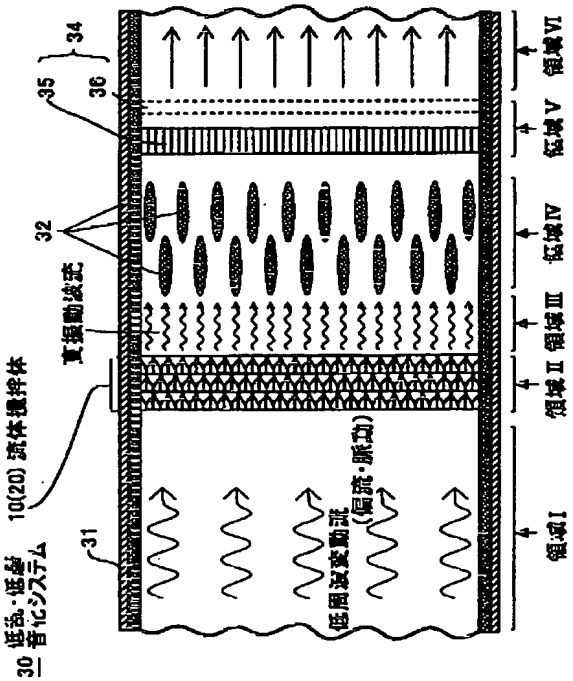
最終頁に続く

(54)【発明の名称】　流体撹拌体、及びそれを用いた流体流れの低乱・低騒音化システム

(57)【要約】
【課題】　風洞試験設備や空調設備等における気流の乱れと騒音の低周波数帯域成分を、一旦、減衰しやすい高周波帯域成分に変調することで、乱れと騒音の低減化を達成する流体流れの低乱・低騒音化システムを提供する。
【解決手段】　風路に設けられる流体撹拌体１０は、風路を流れる流体流れの微小流れ毎に回転（捻り）を与える微小撹拌素子をハニカム状に集合させた流体撹拌層２２，２３，２２を積層して構成されている。一様流に含まれる変動周期の長い低周波成分である偏流や脈動は、流体撹拌体１０を通過するときに減衰しやすい高周波帯域のマイクロ渦流に変調される。高周波の騒音は、流体撹拌体１０の後流側に配設された騒音低減手段である吸音材３３によって更に減衰される。吸音材３３の後流には、整流用のハニカムや網からなる整流機構３４を設けることができる。



【特許請求の範囲】
【請求項１】　流体通路を流れる流体の微小流れ毎に捻りを与える複数の微小撹拌素子が集合配置されて成ることを特徴とする流体撹拌体。
【請求項２】　前記微小撹拌素子は、前記流体流れの方向に沿って配置される筒体と、前記筒体内に配置され且つ捻られた板材から成る捻りエレメントとを有することを特徴とする請求項１に記載の流体撹拌体。
【請求項３】　前記筒体は、円筒セル、四角筒セル、六角筒セル等の筒状セルであることを特徴とする請求項２に記載の流体撹拌体。
【請求項４】　前記捻りエレメントは、軸流方向に沿う軸の回りに３０度～１８０度の範囲内の角度で捻られた薄板であることを特徴とする請求項２又は３に記載の流体撹拌体。
【請求項５】　前記薄板又は前記筒体には、前記流体の通過を許容する小孔が形成されていることを特徴とする請求項２～４のいずれか１項に記載の流体撹拌体。
【請求項６】　前記微小撹拌素子は、前記筒体の内部に複数の前記捻りエレメントが前記流体の流れ方向に沿って捻り方向を交互に連接して配置された多連撹拌素子であることを特徴とする請求項２～５のいずれか１項に記載の流体撹拌体。
【請求項７】　前記微小撹拌素子は前記筒体の内部に一つの前記捻りエレメントを配置した単一撹拌素子であり、前記単一撹拌素子を面状に集合配置して形成された流体撹拌層が、前記流体の流れ方向に沿って連なる前記微小撹拌素子の前記捻りエレメントの捻り方向を交互にして、複数段積ねられて構成されていることを特徴とする請求項２～５のいずれか１項に記載の流体撹拌体。
【請求項８】　前記微小撹拌素子は捻られた板状に形成された捻りエレメントであり、捻り方向を揃えて縦横に並べて配置された前記捻りエレメントの縦方向又は横方向に面一状に並んだ端部列が共通の桁板に連結されていることを特徴とする請求項１に記載の流体撹拌体。
【請求項９】　前記捻りエレメントと前記桁板とは、セラミックス材料の焼結、又は樹脂材料の真空焼結によって、一体的に成形されていることを特徴とする請求項８に記載の流体撹拌体。
【請求項１０】　請求項１～９のいずれか１項に記載の前記流体撹拌体を、乱れ又は騒音を伴う前記流れに対して適用することで構成されていることから成る流体流れの低乱・低騒音化システム。
【請求項１１】　前記流体通路において、前記流体撹拌体の後流側には騒音低減手段が配設されていることから成る請求項１０に記載の流体流れの低乱・低騒音化システム。
【請求項１２】　前記騒音低減手段は、前記流体通路の壁面の一部を構成する吸音壁、又は前記流体通路の壁面に設けられた吸音パネルであることを特徴とする請求項１１に記載の流体流れの低乱・低騒音化システム。
【請求項１３】　前記騒音低減手段は、前記流体撹拌体を通過した前記流体から発生する音に対して逆位相の音を発生させるアクティブノイズコントロール手段であることを特徴とする請求項１１に記載の流体流れの低乱・低騒音化システム。
【請求項１４】　前記騒音低減手段の後流には、前記流体の流れを整流化する整流機構が配設されていることから成る請求項１１～１３のいずれか１項に記載の流体流れの低乱・低騒音化システム。
【請求項１５】　前記流体撹拌体を前記流体通路の一部を構成する集合胴に配置することにより、風洞試験設備に適用されることを特徴とする請求項１０～１４のいずれか１項に記載の流体流れの低乱・低騒音化システム。
【請求項１６】　前記流体撹拌体を室内側の送風口又は室外側の排風口に配置することにより、空調システムに適用されることを特徴とする請求項１０～１４のいずれか１項に記載の流体流れの低乱・低騒音化システム。
【請求項１７】　前記流体撹拌体を熱排出用に設けられる冷却ファンの排気口に配置すること又は前記冷却ファンの排気口に組み込むことにより、パーソナルコンピュータや計測機器等の要冷却電子機器に適用されることを特徴とする請求項１０～１４のいずれか１項に記載の流体流れの低乱・低騒音化システム。
【請求項１８】　前記流体撹拌体は、高速道路等の道路側壁に適用されていることから成る請求項項１０～１４のいずれか１項に記載の流体流れの低乱・低騒音化システム。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】この発明は、風洞試験設備、空調 換気設備、空冷用のファンを有する機器、高速道路などの道路側壁等のような乱れや騒音を伴う流体流れがある機器や設備に対して適用可能な流体撹拌体、及びその流体撹拌体を用いた低乱・低騒音化システムに関する。
【０００２】
【従来の技術】従来、例えば風洞試験設備は、航空機開発の歴史と共に発達してきており、現在では低速から極超音速域までの流体速度に対応した各種風洞試験設備が開発されている。風洞試験設備は、固定翼機やヘリコプター等の回転翼機の開発において、空力特性の把握、層流から乱流への遷移の解明、騒音対策の研究等を目的として航空機分野で利用されているのみならず、例えば、自動車、橋梁、建築、環境等の他産業の分野へと利用が拡大すると共に、風洞試験設備自体についても、得られる気流特性の向上が望まれている。
【０００３】近年、風洞試験設備のこうした利用技術の多様化に伴い、航空機の研究開発分野においては、空力特性の向上に向けた機体（胴体、主翼等）表面上の遷移

メカニズム、ヘリコプターのロータ騒音発生メカニズム等の各種現象メカニズムを解明するのに必要な性能を満たす試験設備が求められており、そうした試験設備を実現するには、風洞気流の乱れ・騒音の低減化に関する低乱・低騒音化技術は欠くことができないものとなっている。循環型の風洞試験設備は、一般に、送風機（軸流ファン）、拡散筒（第１～第３）、屈曲部（第１～第４）、中間筒、集合胴（整流ハニカム・網）、縮流胴、測定部等から構成されている。

【０００４】また、最近では、高層ビルや大型プラント設備に用いられる大型空調・排風設備等から発生する低周波騒音等に対する環境対策が重要になってきている。即ち、大型空調・排風設備では、風洞設備と同様に、ファンから騒音が外部に放出されており、特に低周波騒音については、送風機や排風機の周囲に居る人間や家畜等にストレス等の有害な影響を与えているとして問題となっている。

【０００５】循環型等の風洞試験設備や空調・換気設備等におけるファン流を低乱・低騒音化するには、整流装置及び吸音壁等の各機能設備が必要である。（１）気流を発生させるファン装置には、高動圧・高風量が得られる大型軸流ファンによる単体方式と、低動圧・低風量用の小型軸流ファンを複数台束ねた複合方式がある。両方式においてこれらの要求を満たすためには、従来、種々の対策が講じられている。即ち、大型ファン方式による風洞試験設備の気流の低乱化技術としては、ファンによって風路内に生じる大きな旋回流(偏流・脈動流)による気流の乱れを、整流翼列（コーナ翼列）の増設、整流格子(平行ハニカム)の厚み増し、及び乱れを小さくするスクリーン(金網)の細メッシュ化によって整流し、更に縮流胴で流れを絞ることで一定の気流分布(速度・圧力・乱れ)特性を確保する方法が考えられている。複合ファン方式の場合には、ファン毎に発生する旋回流がお互いに干渉し合って小さな偏流・脈動流となる特性があり、翼列と格子及びスクリーンの効果が大きく、乱れの小さな気流分布(速度・圧力)特性が得られやすいが、風洞設備としては効率が悪い。大型ファン方式による旋回流によって発生するファン流シア(風の断層)や構造物(翼列・壁)等から発生する騒音の低騒音化技術としては、風路内に騒音を吸収する吸音壁、吸音パネルの増設、厚み増し等によるパッシブ方式の技術がある。

【０００６】（２）風洞の各構造物から発生する機械的振動の低減技術として、要素構造物毎に切り離した構造とする方法がある。また、（３）高周波帯域の騒音の低減に有効な技術として、マイクロホンとスピーカを用いたアクティブノイズコントロール方式がある。アクティブノイズコントロール方式は、騒音をマイクロホンで捕らえて、リアルタイムで騒音波長に合わせた逆位相の波長音を作り、その逆位相の波長音を音源に向けて出すことによって、騒音を打ち消し合って低減させるものである。

【０００７】

【発明が解決しようとする課題】しかしながら、（１）コーナ翼列、整流ハニカム、網及び吸音パネルの配設等の技術については、次のような問題点がある。即ち、コーナ翼列の枚数増設は、枚数を増加するほど増加する抗力によって送風機効率の低下を招く。また、整流ハニカムについては、コアの開口比を小さくしコアの厚みを増すことで、高周波帯域の整流効果が顕著であるが、低周波帯域の変動流に対しては圧力波がハニカムを通過しやすいため効果が小さい。網の開口比を小さくすれば乱れを小さくできるが、流体流れに対する網による抗力が大きくなり、その結果、送風機効率の低下や目詰まりによる分布特性の悪化を招き、更に低周波帯域の変動流については依然として大きな効果が得られない。更に、多孔板とグラスウールマット等から成る吸音パネルの設置は、低周波から高周波までの広帯域での騒音に有効であるが、孔を通過した音波が、パネル間で反射し合うときの減衰を利用するだけであり、有効に機能させるには波長に合わせたパネルの厚みと波長の周期に合わせた長い設置空間が必要となり、風路の直径と長さの点で大型化が問題となる。

【０００８】（２）送風機やコーナ翼列等の風路内構造物から発生する振動については、各要素構造物（送風機、宿流胴、測定部、拡散胴）毎に切り離した構造とすることで測定部への影響を小さくすることができるが、流体流れ自体に乱れや騒音を伴っているときには、十分な対応ができない。

（３）アクティブノイズコントロール方式の技術は、風量が小さい小型設備でスピーカの周波数特性（数Ｈｚ以上）の範囲内であれば適用しても有効であるが、風洞試験設備、大型空調・プラント設備については、特に数Ｈｚ以下の低周波帯域の脈動流については適用できても所期の効果を得るには膨大なエネルギーを必要とするために実用的ではない。

【０００９】しかし、一般に送風・排風気流のうち高周波帯域の騒音は空気を媒体とした距離による減衰効果が大きく低減化は容易であるが、上記の各整流手段や吸音手段は、振動周期の長い低周波(低振動波)騒音に対する対応が難しく、低周波数帯域における乱れと騒音とを十分満足できるほどに低減させることはできない。最新の研究水準に対応できる風洞設備としては、気流乱れの低乱化と騒音の低騒音化との両技術を確立することが重要となる。

【００１０】そこで、風洞試験設備、大型空調・プラント設備のように、大型の送風ファンや排気ファン、あるいは複合ファンによる低周波帯域の乱れや騒音を伴う流体の流れが存在している場合において、新しい発想の下、変動周期の長い低周波成分である脈動偏流を、低減化しやすい高周波(高振動波)の乱れを伴うマイクロ渦流

に一旦変調させることで、低乱・低騒音化を達成する点で解決すべき課題がある。

【００１１】この発明の目的は、循環型等の風洞試験設備、空調設備、大型プラント、高速道路などの道路側壁等における流体流れに存在する低周波変動流成分（ファンによる偏流・脈動流）と騒音の低周波成分とを同時に低減化することができる流体撹拌体、及びその流体撹拌体を用いた低乱・低騒音化システムを提供することである。

【００１２】

【課題を解決するための手段】上記課題を解決するため、本発明による流体撹拌体は、流体通路を流れる流体の微小流れ毎に捻りを与える複数の微小撹拌素子が集合配置されて構成されていることを特徴としている。

【００１３】この流体撹拌体によれば、複数の微小撹拌素子が集合配置されているので、低周波帯域の大きな偏流・脈動を伴った一様な流体流れが流体通路を流れて流体撹拌体を通過するとき、微小撹拌素子が流体の微小流れ毎に捻りを与え、その結果、低周波帯域の偏流・脈動は一定の高周波帯域のマイクロ渦流に変調させられる。また、流体が伴う騒音に関しては、動圧成分については偏流・脈動と同様に微小撹拌素子の捻り作用によって高周波成分に変調され、粗密波のような静圧成分については微小撹拌素子表面での反射の繰り返しによって生じる干渉で減衰されたり変調によってやはり高周波成分に変換される。高周波数成分から成るマイクロ渦流や騒音は、低周波数帯域の成分と比較して減衰・消音しやすく、流体撹拌体を通過した後では十分低乱・低騒音の流れとなる。従って、この発明によれば、ファン流の低周波振動成分（偏流・脈動流）と低周波騒音とは同時に低減される。

【００１４】この流体撹拌体において、前記微小撹拌素子は、前記流体流れの方向に沿って配置される筒体と、前記筒体内に配置され且つ捻られた板材から成る捻りエレメントとを有することができる。筒体及び板材は、共に簡単な構成の素材であって加工も簡単であり、筒体と捻り板材の組み合わせで微小撹拌素子を簡単な構造に且つ大量に製作することが可能である。特に、流れが有する騒音については、音の粗密波が捻りエレメントの形状に起因して流れに交差する方向に複雑に反射することで、効果的に減衰される。

【００１５】上記の捻りエレメントを有する微小撹拌素子において、前記筒体は、円筒セル、四角筒セル、六角筒セル等の筒状セルとすることができる。筒体の形状を円筒セルや角筒セル等の筒状セルとすることにより、複数の微小撹拌素子を密度の高い密集状態に集合させた流体撹拌体が得られ、流体を効率的に微小な流れに分割して、流体流れの殆ど又はすべての部分について分割された微小流体毎に捻りを与えることが可能となる。また、前記捻りエレメントは、軸流方向に沿う軸の回りに３０度～１８０度の範囲内の角度で捻られた薄板で構成することができる。捻り角度が３０度未満では低周波帯域の変動成分を高周波帯域の変動成分に変換するマイクロ渦流の生成が小さく、乱れと騒音との効率的な減衰を期待できない。捻り角度が１８０度を超えると、却って流れに大きな乱れを生じることになり、抗力も増加するためやはり乱れと騒音との効率的な減衰を期待できない。更に、前記薄板又は筒体に前記流体の通過を許容する小孔を形成することにより、流体が小孔を通過可能となって、より細かい微小渦の形成が促され、乱れと騒音が一層低減される。

【００１６】上記の捻りエレメントを有する流体撹拌体において、前記微小撹拌素子は、前記筒体の内部に複数の前記捻りエレメントが前記流体の流れ方向に沿って捻り方向を交互に連接して配置された多連撹拌素子とすることができる。左右の捻り方向を違えた捻りエレメントを筒内において交互に重ね合わせることにより、低周波の変動分及び騒音を伴う流体流れは、各捻りエレメントにおける連続する撹拌作用によって一層の高周波成分に変換され、変動及び騒音をより減衰しやすくなる。

【００１７】上記の捻りエレメントを有する流体撹拌体において、前記微小撹拌素子は前記筒体の内部に一つの前記捻りエレメントを配置した単一撹拌素子であり、前記流体撹拌体は、前記単一撹拌素子を面状に集合配置させて形成した流体撹拌層を、前記流体の流れ方向に沿って連なる前記微小撹拌素子の前記捻りエレメントの捻り方向を交互にして、複数段積ねることで構成することができる。複数の流体撹拌層を積層したときにおいて、一つの微小流体流れの方向で見て各流体撹拌層の微小撹拌素子の捻り方向を左右交互に違える状態に流体撹拌層を交互に重ね合わせることにより、低周波の変動分及び騒音を伴う流体流れは、複数段に重なり合う各流体撹拌層の微小撹拌素子による連続する撹拌作用によって一層の高周波成分に変換され、変動及び騒音をより減衰しやすくなる。なお、各流体撹拌層の積層の仕方については、各層の微小湯撹拌素子が流体流れの方向に正しく整列した状態に積層させてもよく、また、各層の微小湯撹拌素子が流体流れの方向に千鳥状に整列した状態に積層させてもよい。

【００１８】この発明による流体撹拌体において、前記微小撹拌素子は捻られた板状に形成された捻りエレメントであり、捻り方向を揃えて縦横に並べて配置された前記捻りエレメントの縦方向又は横方向に面一状に並んだ端部列を共通の桁板に連結して構成することができる。この流体撹拌体によれば、捻られた板状に形成された捻りエレメントの流体流れに対して入口側となる端部は、縦横のいずれかの方向に面一状に並んだ端部列となっており、共通の桁板に連結されている。また、流体流れに対して出口側となる端部も、縦横の他方の方向に面一状に並んだ端部列となっており、共通の桁板に連結されて

いる。従って、捻りエレメントの集合体は、両側で縦又は横の桁板の列で一体化されており、多数の捻りエレメントを剛性の高い一つの物品として取り扱うことが可能になる。

【００１９】上記の捻りエレメントの両端部が桁板で連結された流体撹拌体において、前記捻りエレメントと前記桁板とを、セラミックス材料の焼結、又は樹脂材料の真空焼結によって、一体的に成形することができる。焼結又は真空焼結によって成形することで、例えば、光造形手法を利用することができ、複雑な形状を有する流体撹拌体でも容易に型成形することが可能である。

【００２０】上記の流体撹拌体を、乱れ又は騒音を伴う前記流れに対して適用することで、流体流れの低乱・低騒音化システムを構成することができる。流体通路内を流れる流体には、様々な原因で乱れと騒音を伴うことがあり、そのような場合に、流体通路内に流体撹拌体を配置することで、流体撹拌体の高周波帯域への変調作用及び騒音減衰作用によって、低乱・低騒音化を図ることが可能である。

【００２１】この流体流れの低乱・低騒音化システムにおいて、前記流体通路の前記流体撹拌体の後流側には騒音低減手段を配設することができる。騒音低減手段を配設することによって、更に高周波成分の騒音は騒音低減手段によって一層効率的に消音される。前記騒音低減手段は、前記流体通路の壁面の一部を構成する吸音壁、又は前記流体通路の壁面に設けられた吸音パネルとするのが好ましい。流体撹拌体を通過することで高周波帯域のマイクロ渦流に変換された偏流・脈動が発生する高周波帯域の騒音は、流体撹拌体の後流に配設された吸音パネルで効果的に吸収されやすくなるので、流れの低騒音化が一層進められる。

【００２２】この流体流れの低乱・低騒音化システムにおいて、前記騒音低減手段は、前記流体撹拌体を通過した前記流体から発生する音に対して逆位相の音を発生させるアクティブノイズコントロール手段とすることが可能である。アクティブノイズコントロールは、マイクロフォンで捕らえた音源の音波と逆位相の音波をスピーカから音源に向けて発生させることにより、音源の音と打ち消し合わせて消音を図る手法である。流体撹拌体で高周波帯域に変換された騒音は、従来のスピーカの周波数特性（数Ｈｚ以上）である高周波帯域の成分の音に対して効果のあるとされるアクティブノイズコントロール手段を適用して、低周波数帯域の騒音が低減される。

【００２３】この低乱・低騒音化システムにおいて、前記騒音低減手段の後流には、前記流体の流れを整流化する整流機構を配設することができる。高周波帯域に変換された偏流・脈動は、減衰しやすく、そのままでも実用に適するが、騒音低減手段の後流に平行ハニカムや網等から構成される整流機構を配設することにより、更に一層、安定した流体流れが得られる。

【００２４】この流体流れの低乱・低騒音化システムは、前記流体流れを生じさせるファンを持つ送風機、排風機及びそれらを組み込んだ機器・設備に適用可能であり、低乱・低騒音化システムがそのように適用されたファン流については、低周波振動成分(偏流・脈動流)と低周波騒音とが同時に低減される。その一例として、流体撹拌体を前記流体通路の一部を構成する集合胴に配置することにより、低乱・低騒音化システムを風洞試験設備に適用することができる。また、流体流れの低乱・低騒音化システムは、前記流体撹拌体を室内側の送風口又は室外側の排風口に配置することにより、空調システムに適用することもできる。また、流体流れの低乱・低騒音化システムは、前記流体撹拌体を熱排出用に設けられる冷却ファンの排気口に配置すること又は前記冷却ファンの排気口に組み込むことにより、パーソナルコンピュータや計測機器等の要冷却電子機器にも適用することができる。更に、前記流体撹拌体は、騒音低減作用に着目して、高速道路等の道路側壁に適用することもできる。

【００２５】

【発明の実施の形態】以下、添付図面を参照して、この発明による流体撹拌体の実施例、及び当該流体撹拌体が流体流れの低乱・低騒音化システムとしての風洞試験設備や排風設備等に適用された実施例とを詳細に説明する。まず、微小撹拌素子を用いた流体撹拌体の構成等について説明する。図１（ａ）～図１（ｃ）は、この発明による流体流れの流体撹拌体を構成する微小撹拌素子の捻りエレメントの例を示す斜視図である。

【００２６】図１（ａ）に示す微小撹拌素子１ａは、薄板素材をそのエレメント軸線３の回りに捻って形成した捻りエレメント２Ｌと、捻りエレメント２Ｌを内部に収容する筒体としての円筒セル４ａとを備えた単一撹拌素子である。図１（ａ）の例では、捻りエレメント２Ｌは流入した微小流体流れをその流れ方向に見て左に捻る左捻りエレメントである。左捻りエレメント２Ｌは円筒体４ａを流体の流入口及び流出口を含むどの断面でも円筒セル４ａの断面を二分する形状となっている。図１（ｂ）に示す微小撹拌素子１ｂは、薄板素材をエレメント軸線３の回りに捻って形成され通過する微小流体を左に捻る左捻りエレメント２Ｌと、左捻りエレメント２Ｌを内部に収容する筒体としての角筒セルとを備えている。角筒セルは、この例では六角筒セル４ｂである。左捻りエレメント２Ｌは六角筒セル４ｂを入口と出口において２分割している。なお、単一撹拌素子としては、通過する微小流体を左に捻るのみならず、右に捻る右捻りエレメントを備えたものであってもよい。

【００２７】図１（ｃ）は、左捻りエレメント２Ｌと右捻りエレメント２Ｒを間隔ｅだけ離して一つの長い円筒セル４ｃ内にエレメント軸線３に沿って連設した多連撹拌素子としての微小撹拌素子１ｃを示す。円筒セル４ｃ内に流入した微小流体流れは、左捻りエレメント２Ｌに

よって左旋廻された後、右捻りエレメント２Ｒによって戻される方向の回転を受ける。図１（ａ）～図１（ｃ）に示す例では、個々の捻りエレメント２Ｌ，２Ｒの入口側と出口側との間での相対捻れ角度は９０度にされているが、この相対捻れ角度は、９０度に限ることなく、マイクロ渦流を効率的に発生させることができる３０度～１８０度の範囲であればよい。相対捻れ角度が３０度未満では、マイクロ渦流の発生が少なすぎ、相対捻れ角度が１８０度を超えるときには却って流れに乱れが発生する。

【００２８】流体撹拌の原理について、その概要を図１（ｃ）に基づいて説明する。ファン（後述する）によって生じた旋回流(偏流・脈動流)は、一段目の円筒セル４ｃの流入口で左捻りエレメント２Ｌによって上下に２分割された流れＳｔ，Ｓｂとなり、回転されながら左捻りエレメント２Ｌ後部の流出口側では左右の２分割渦流Ｓｌ，Ｓｒとなる。次に、左右２分割渦流Ｓｌ，Ｓｒは二段目に設けられている下流の右捻りエレメント２Ｒに流入し、更に２分割されて右捻りエレメント２Ｒの後部では小さな４分割渦流（マイクロ渦流）Ｓｍｖとなり、高変動流（圧力変動と騒音）成分を有する流れになる。

【００２９】また、各エレメント２Ｌ，２Ｒは、流体流れに生じている騒音に関しては、動圧成分については偏流や脈流と同様に高周波成分に変調させることで減衰させやすくし、粗密波のような静圧部分については各レメント２Ｌ，２Ｒの表面で複雑な反射を繰り返すことで、減衰させたり高周波成分へ変換させる作用がある。後述するように、流体撹拌体は、微小撹拌素子を、その筒体の軸線が流体流れに沿うように、流体通路を横切る横断断面に渡って敷き詰められた状態で集合されて構成されるので、流体撹拌体の全域にわたってマイクロ渦流Ｓｍｖが発生するために、風路断面内の気流は一様流に生じている低周波帯域の乱れや騒音は高周波成分に変調される。

【００３０】図２は、捻りエレメントや筒体に流体の通過を許容する孔を形成した例を示す斜視図である。図２（ａ）及び図２（ｂ）には、それぞれ、流体の通過を許容する多数の孔５が形成された左捻りエレメント２Ｌ、右捻りエレメント２Ｒが示されている。図２（ｃ）に示す六角筒セル４ｂには、流体の通過を許容する多数の孔６が形成されている。筒体が図１（ａ）に示すような円筒セル４ａの場合も同様である。

【００３１】図３は、低周波を伴う流体流れを、高周波成分を持つ流れに変換するため、図１に示した微小撹拌素子を多数個組み合わせて構成した流体撹拌体の一例を示す図であり、図３（ａ）はその流体撹拌体の正面図、図３（ｂ）は図３（ａ）に示す流体撹拌体のＡ－Ａ断面図である。図３に示す流体撹拌体１０は、一つの円筒セル４ａ内にそのセル内での流体の流れ方向に沿って、複数の左右捻りエレメント２Ｌ，２Ｒを交互に連設して成る微小撹拌素子１ｄを多数並列に集合させて構成されている。図の例では、流体が流れる通路（空気のような気体が流れる場合は、風路）が断面六角形であるので、多数の微小撹拌素子１ｄを集合させた流体撹拌体１０の外形をその断面形状に合わせて六角形状にすることで、風路の断面を埋めることができる。一つの筒体内に連設されるエレメントの数は３つであり、従って、流体が捻られる捻りパターンは２Ｌ，２Ｒ，２Ｌ又は２Ｒ、２Ｌ、２Ｒのように２つのタイプがある。また、図の上半分における微小撹拌素子１ｄの集合部と図の下半分における微小撹拌素子１ｄの集合部とで、捻りエレメントの捻りパターンを逆にしてある。流体撹拌体１０は、多数の微小撹拌素子１ｄを全体が六角状のバンド又は枠体１１内に集合させてハニカム状に組み込まれている。

【００３２】図４は図１に示した微小撹拌素子を多数個組み合わせて構成した流体撹拌体の別の例を示す図であり、図４（ａ）はその流体撹拌体の正面図、図４（ｂ）は図４（ａ）に示す流体撹拌体のＢ－Ｂ断面図である。図４に示す流体撹拌体２０は、図１（ｂ）に示したような六角筒セル４ａ内に左捻りエレメント又は右捻りエレメント２Ｌ，２Ｒのいずれかを組込んだ微小撹拌素子１ｃを多数集合させた流体撹拌層２２，２３を複数段に積層して構成されている。筒体を六角筒セル４ａとすることにより、風路の断面を完全に埋めることができる。各流体撹拌層２２，２３は、多数の微小撹拌素子１ｃを全体が六角状のバンド又は枠体２１内に集合させてハニカム状に組み込まれている。図示の例では、第１段～第３段には、それぞれ流体撹拌層２２，２３，２２が３段に積層されており、各流体撹拌層２２，２３は、図の上半分の集合部と下半分の集合部とで、捻りエレメントの捻りパターンを異ならせてある。しかしながら、流体の流れ方向で見た捻りパターンは、図３に示す例と同様に、２Ｌ，２Ｒ，２Ｌ又は２Ｒ、２Ｌ、２Ｒのように交互に設定されており、全体の輪郭形状も、流体通路の形状（断面六角形）に合わせた形状にされている。

【００３３】図４に示す流体撹拌層２２，２３を多段形式に積層させる場合、図５に示すように、隣り合う流体撹拌層で、積層させる態様を選択することができる。図５（ａ）は、距離ｅ１を置いて隣り合う流体撹拌層２１，２２において捻り方向の異なる各微小撹拌素子を同軸に整列させた同軸配置態様を示す断面図であり、例えば、上流側の流体撹拌層２１の微小右撹拌素子１Ｒに対して、下流側の微小左撹拌素子１Ｌは、互いの筒体の軸線を同軸上に置いた状態に配置されている。上流側の微小右撹拌素子１Ｒに流入した流体は、理想的には、整列した下流側の微小左撹拌素子１Ｌにそのまま流入し、上流側の微小右撹拌素子１Ｒの右捻りエレメント２Ｒで分割された流れが、後流側の微小左撹拌素子１Ｌの左捻りエレメント２Ｌで混合撹拌される。また、図５（ｂ）は、距離ｅ２を置いて隣り合う流体撹拌層２１，２２に

おいて捻り方向の異なる各微小撹拌素子１Ｒ，１Ｌを千鳥状にずらせた千鳥配置態様を示す断面図であり、例えば、上流側の流体撹拌層２１の微小右撹拌素子１Ｒに対して、下流側の微小左撹拌素子１Ｌは、互いの筒体の軸線を千鳥状にずらせて配置されている。上流側の微小右撹拌素子１Ｒに流入した流体は、千鳥状に跨って続く下流側の二つの微小左撹拌素子１Ｌ，１Ｌに分かれて流入し、混合撹拌される。

【００３４】図６は、この発明による流体撹拌体の別の実施例を示す斜視図である。図６に示す流体撹拌体２５の微小撹拌素子は、板状に形成された捻りエレメント２６であり、複数の捻りエレメント２６（一部にのみ符号を付す）は捻り方向を揃えて縦横に並べて格子状に配置されている。流体撹拌体２５においては、捻られた板状に形成された捻りエレメント２６の一方の端部２６ａ（例えば、流体流れに対して入口側となる端部）の列は、横方向に面一状に並んだ横端部列となっており、各横端部列はその列と同じ面一状に延びる共通の横桁板２７（２７ａ，２７ｂ，２７ｃ・・・）に連結されている。同様に、捻りエレメント２６の他方の端部２６ｂ（例えば、流体流れに対して出口側となる端部）の列は、縦方向に面一状に並んだ縦端部列となっており、各縦端部列はその列と同じ面一状に延びる共通の縦桁板２８（２８ａ～２８ｆ・・・）に連結されている。捻りエレメント２６の集合体としての流体撹拌体２５は、両側でそれぞれ異なる方向に並ぶ桁板の列，即ち横桁板２７の列と縦桁板２８の列で一体化されており、流体撹拌体２５の設置、交換等の作業において、多数の捻りエレメント２６を剛性の高い一つの物品として取り扱うことができる。流体撹拌体２５は捻りエレメント２６を囲む筒体を備えていないので、流れに生じている騒音については、音波はエレメント２６間での複雑な反射を繰り返し、一層、効果的に減衰される。

【００３５】捻りエレメント２６の両端部２６ａ，２６ｂを横桁板２７の列と縦桁板２８の列とで連結された流体撹拌体２５を製造するに際して、捻りエレメント２６と各桁板２７，２８とは、セラミックス材料の焼結、又は樹脂材料の真空焼結によって、一体的に成形することができる。焼結又は真空焼結によって成形することで、例えば、光造形（ＲＰ）手法を利用することができ、複雑な形状を有する流体撹拌体２５でも容易に型成形することができる。流体撹拌体２５をセラミックス材料で成形する場合には、容易に多孔質に形成して軽量にすることができ、更に、流体撹拌体２５は、その入口側と出口側とをそれぞれ横桁板２７と縦桁板２８とによって一体化成形されているため、全体としては格子状を形成し高強度に構成することができる。

【００３６】次に、風路に設けた流体流れの低乱・低騒音化システムの全体構成について、図７及び図８の記載に基づいて説明する。図７は流体撹拌体と騒音低減手段とを備えたこの発明による低乱・低騒音化シテムの概要を示す断面図であり、図８は図７に示す低乱・低騒音化システムの各領域での乱れ・駐音の変動物理量を説明するグラフである。低乱・低騒音化シテム３０は、基本的には、六角形状の通路断面を有する風路壁３１に、図３、図４又は図６に示したような多段構造の流体撹拌体１０（２０，２５）を配設し、流体撹拌体１０（２０，２５）の後流に騒音低減手段３２を配設し、更に、騒音低減手段３２の後流の風路内に整流機構３４を配設することによって構成されている。図示しない上流側には、送風機又は排風機の軸流ファンや複合ファンが配設されており、このファンの作用に起因して、風路の領域Ｉを流れる流体流れは、図８（ａ）に示すように、偏流・脈動を伴う一様流、即ち、時間経過に対して流変動流が大きく表れる低周波変動流が重畳せられた変動の大きな基本流である。

【００３７】ファンによる流れは、先ず、領域ＩＩ（振動変調領域）に設けられた流体撹拌体１０（２０，２５）において、１段目のハニカム状に構成された流体撹拌層２２の各セルに入り２分割され、次に２段目のハニカム状に構成された流体撹拌層２３にて更に４分割され、３段目のハニカム状に構成された流体撹拌層２２で更に細分化されて振動変調を受け、領域ＩＩＩ（定常振動波流領域）では、マイクロ渦流を有する一様流に変換される。この一様流は、図８（ｂ）に示すように、流れ変動量が高周波帯域の成分のみとなっている。その下流側の風路である領域ＩＶ（定常振動波軽減領域）には、騒音低減手段３２として吸音パネル３３が風路壁３１に設けられており、マイクロ渦流の高周波帯域成分を吸収する。高周波帯域成分の乱れと騒音が吸収された後の流れ変動量の様子が、図８（ｃ）に示されている。高周波帯域成分が軽減化された一様流は、その後流の領域Ｖ（整流領域）において整流機構３４にて更に整流され、領域ＶＩ（低乱・低騒音流領域）では安定した低乱・低騒音流となる。整流機構３４は、具体的には、整流用平行ハニカム３５や整流網３６等で構成される。低乱・低騒音流は、その後、縮流胴等にて、更に安定した流れとされた上で測定部に供給される。

【００３８】この発明による流体流れの低乱・低騒音システムを風洞試験設備の集合胴に適用した例が、図９に概要図として示されている。図９に示す風洞試験設備４０は、電動モータ４１によって回転駆動されるファン４２によって気流を循環させている循環型の風洞設備である。ファン４２の後流には、ファン４２からの流れが拡散しながらも大きな偏流・脈動を伴って流れる第１拡散胴４３が設けられている。第１拡散胴４３の後流には順次、第１屈曲部４４、中間胴４５、第２屈曲部４６、集合胴４７が続き、集合胴４７において、流体撹拌体１０（２０，２５）、騒音低減手段３２及び整流機構３４（整流用平行ハニカム３５や整流網３６）を備えた本発

明による低乱・低騒音システム３０が適用されている。低乱・低騒音システム３０によって流れ変動量が軽減された低乱・低騒音流れは、縮流胴４８で縮流されて、測定部４９に送られる。測定部４９には、乱れや騒音が一層軽減された流れが供給されるので、精度の良い測定結果が期待できる。

【００３９】この発明による流体流れの低乱・低騒音システムを風洞試験設備の第１拡散胴に適用した例が、概要図として図１０に示されている。図１０に示す風洞試験設備５０には、図９に示した風洞試験設備４０の構造と同等の構造には同じ符号を付すことで再度の詳細な説明を省略する。本発明による低乱・低騒音システム３０は、流体撹拌体１０（２０，２５）をファン４２の後流の第１拡散胴４３に配置し、騒音低減手段３２と整流機構３４とを第２屈曲部４６を経た集合胴４７に配置している。低乱・低騒音システム３０によって流れ変動量が軽減された低乱・低騒音流れは、縮流胴４８で縮流されて、測定部４９に送られる。

【００４０】図１１は、本発明による低乱・低騒音システムが、空調システム６０に適用された例を示す概要図である。図１１に示す適用例では、本発明による低乱・低騒音システムの流体撹拌体１０（２０，２５）が、室内６１の空気を室外６２へ排気するためにモータ６３で駆動されるファン６４が設けられているダクト６５の排風口６６に配設されている。低乱・低騒音システムは、流体撹拌体１０（２０，２５）のみから成るが、流体撹拌体１０（２０，２５）の変調作用によって低周波数の騒音は高周波帯域の騒音に変換され、高周波の騒音はその後急速に減衰するので、結果として空調システムの排風騒音を抑えることができる。勿論、出口側にスペースの余裕があれば、図７に示すような騒音低減手段３２を設けることができるのは明らかである。なお、低乱・低騒音システムは、空調システム６０の室内側の送風口に適用できることも、明らかである。

【００４１】図１２は、本発明による低乱・低騒音システムが、各種の計測装置７０の空冷ファンに適用された例を示す概要図である。図１２に示す適用例では、空冷ファン７１はモータ内蔵式であり、空冷ファン７１を装置フレーム７２に取り付けるブラケット７３の出口側に低乱・低騒音システムの流体撹拌体１０（２０，２５）が設けられている。図１１に示す適用例と同様に、騒音低減手段３２を設けることも可能である。この適用例によれば、計測装置７０の測定精度が冷却ファンの騒音によって影響を受けるのを軽減することができる。また、流体撹拌体１０（２０，２５）は、計測装置７０以外にも、例えば、パーソナルコンピュータのような要冷却電子機器において、その空冷却ファンの出口側にも適用することができ、オフィスの静寂性を高め執務環境の改善に寄与することができる。

【００４２】

【発明の効果】本発明による流体撹拌体は、以上に説明したように、複数の微小撹拌素子が流体通路を横切る面内に集合配置されて構成されているので、低周波帯域の大きな偏流・脈動を伴った一様な流体流れが流体撹拌体を通過するときに、微小撹拌素子が流体の微小流れ毎に捻りを与え、その結果、低周波帯域の大きな偏流・脈動や騒音の動圧成分は、一旦、一定の高周波帯域（乱れ・騒音）のマイクロ渦流や騒音に変調させられる。高周波数成分から成るマイクロ渦流や騒音は、減衰しやすく、流体撹拌体を通過後、急速に減衰する。また、騒音の静圧成分は微小撹拌素子の表面での反射によって減衰されやすくなる。従って、この発明によれば、ファン流の低周波振動成分(偏流・脈動流)と低周波騒音とを同時に低減することができる。

【００４３】この発明は、上記流体撹拌体を風洞設備や空調設備等を代表とする流れに関する種々の設備に対して適用して低乱・低騒音システムとして構成することができる。即ち、上記流体撹拌体を風洞設備に適用することによって、測定部での気流の乱れや騒音を効果的に低減させることができ、航空機等の飛翔体の研究開発や、自動車等の走行物体や建築物等の研究開発の分野で高精度の測定結果が得られる。また、上記流体撹拌体を高層ビルや大型プラント設備に用いられる大型空調・排風設備に適用したシステムは、これら大型空調・排風設備等から発生する低周波騒音を低減することができ、送風機や排風機等のファンの周囲に居る人間や家畜等にストレス等の有害な影響を与える低周波騒音を軽減する環境対策としても有効な手段となり得る。また、高速道路などの道路側壁に適用すれば、騒音の圧力波が流体撹拌体を通過しようとするときに、特に捻りエレメントで上下・左右に複雑に反射することで、大きく減衰される。

【００４４】この発明による流体撹拌体のその他の適用例として、次の低乱・低騒音システムを挙げることができる。即ち、①吹出風洞の消音塔に設ければ小型の設備で低周波騒音を解消することができる。②計測装置の空冷ファンの放出口に設けて室内騒音を低減させることができる。③空港おけるエンジンテスト設備の排ガス吸気防音壁（排気ガス吸い込み口）のような防音壁に設ければ、騒音の軽減効果と排気ガス循環の影響を小さくすることができる。

【図面の簡単な説明】

【図１】この発明による流体流れの低乱・低騒音化システムに用いられる微小撹拌素子の捻りエレメントの例を示す斜視図である。

【図２】捻りエレメントや筒体に流体の通過を許容する孔を形成した例を示す斜視図である。

【図３】図１に示した微小撹拌素子を多数個組み合わせて構成した流体撹拌体の一例を示す図であり、図３（ａ）はその流体撹拌体の正面図、図３（ｂ）は図３（ａ）に示す流体撹拌体のＡ－Ａ断面図である。

【図４】図１に示した微小撹拌素子を多数個組み合わせて構成した流体撹拌体の別の例を示す図であり、図４（ａ）はその流体撹拌体の正面図、図４（ｂ）は図４（ａ）に示す流体撹拌体のＢ－Ｂ断面図である。

【図５】流体撹拌層の積層態様を示す図であり、図５（ａ）は、各流体撹拌層において小撹拌素子を同軸整列させた態様を示す断面図であり、図５（ｂ）は各流体撹拌層において小撹拌素子を千鳥状に整列させた態様を示す断面図である。

【図６】この発明による流体撹拌体の別の実施例を示す部分斜視図である。

【図７】この発明による低乱・低騒音化シテムの概要を示す断面図である。

【図８】図７に示す低乱・低騒音化シテムの各領域での乱れ・駐音の変動物理量を説明するグラフである。

【図９】この発明による流体流れの低乱・低騒音システムを風洞試験設備の集合胴に適用した例を示す概要図である。

【図１０】この発明による流体流れの低乱・低騒音システムを風洞試験設備の第１拡散胴に適用した例を示す概要図である。

【図１１】この発明による低乱・低騒音システムを空調システムに適用した例を示す概要図である。

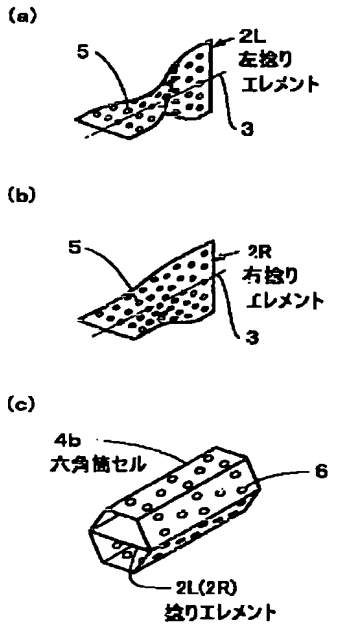
【図１２】本発明による低乱・低騒音システムを計測装置の空冷ファンに適用した例を示す概要図である。

【符号の簡単な説明】

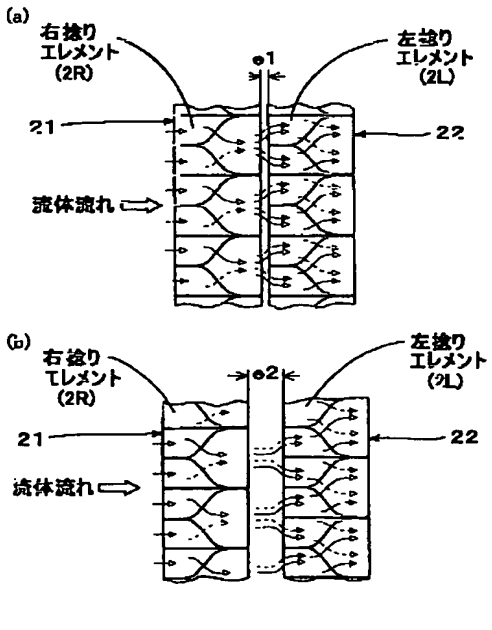
１ａ～１ｄ　微小撹拌素子

１Ｌ	微小左撹拌素子	１Ｒ　微小右撹拌素子
２Ｌ	左捻りエレメント	２Ｒ　右捻りエレメント
４ａ	円筒セル	４ｂ　六角筒セル
５，６孔		
１０，２０，２５	流体撹拌体	２２，２３　流体撹拌層
２６	捻りエレメント	２６ａ，２６ｂ　端部列
２７	横桁板	２８　縦桁板
３０	低乱・低騒音化システム	
３１	風路壁	
３２	騒音低減手段	３３　吸音パネル
３４	整流機構	３５　整流用並行ハニカム
３６	整流網	
４０，５０	風洞試験設備	４２　ファン
４３	第１拡散胴	４７　集合胴
６０	空調システム	７０　計測装置

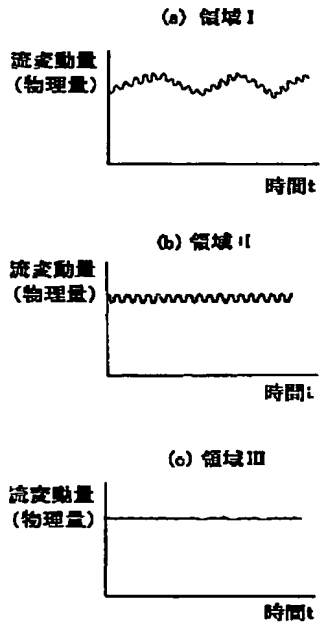
【図２】



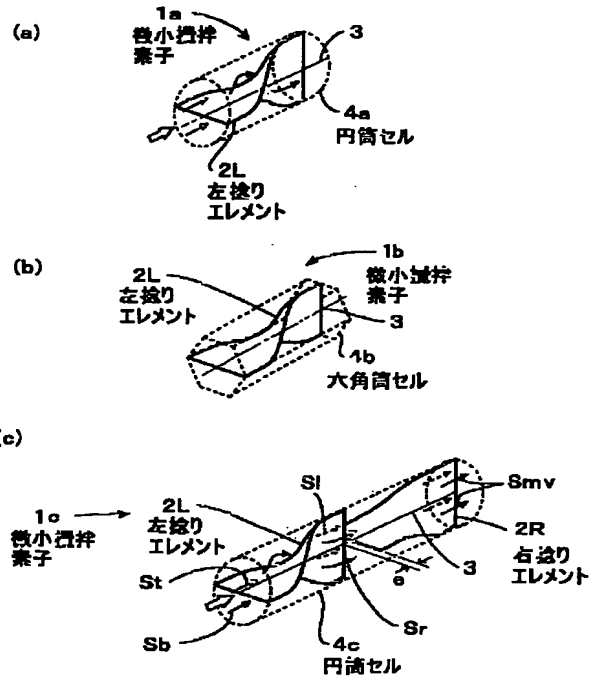
【図５】



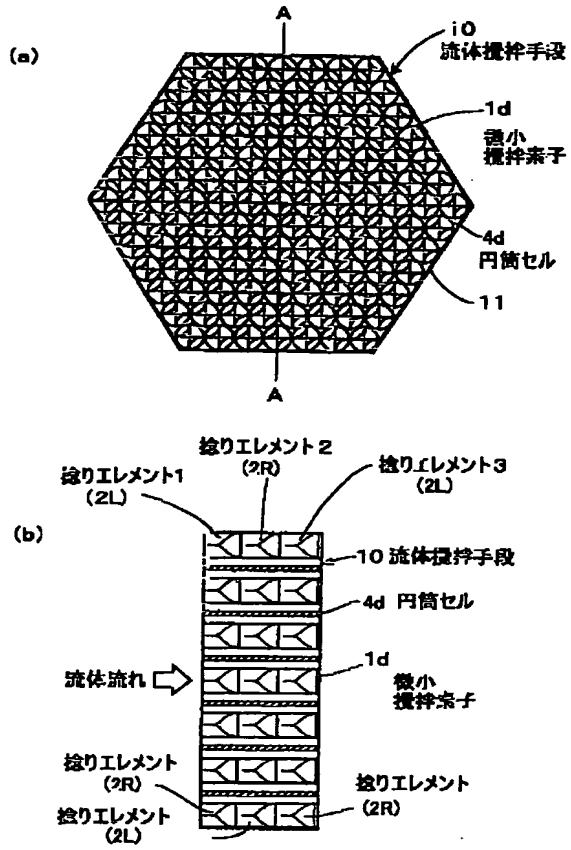
【図８】



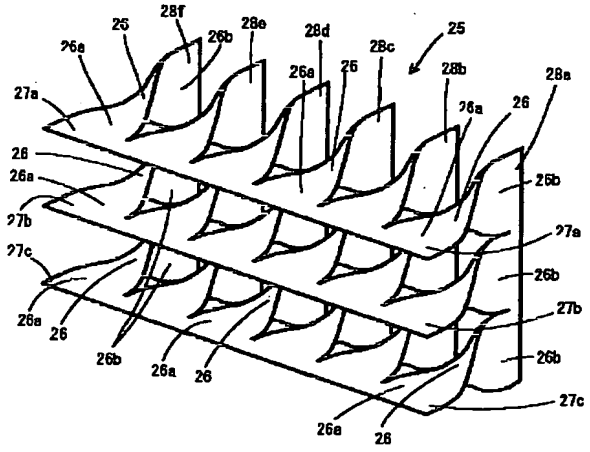
【図1】


(a)
1a
微小攪拌
素子
3
4a
円筒セル
2L
左捻り
エレメント
(b)
1b
微小攪拌
素子
2L
左捻り
エレメント
3
4b
六角筒セル
(c)
1c
微小攪拌
素子
2L
左捻り
エレメント
St
Sb
Sl
Smv
2R
右捻り
エレメント
3
e
Sr
4c
円筒セル

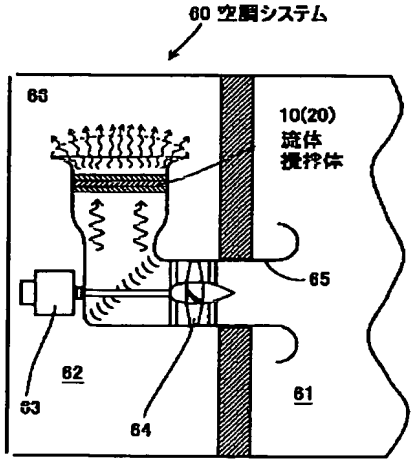
【図3】


(a)
A
10
流体攪拌手段
1d
微小
攪拌素子
4d
円筒セル
11
A
(b)
捻りエレメント2
(2R)
捻りエレメント1
(2L)
捻りエレメント3
(2L)
10 流体攪拌手段
4d 円筒セル
流体流れ
1d
微小
攪拌素子
捻りエレメント
(2R)
捻りエレメント
(2L)
捻りエレメント
(2R)

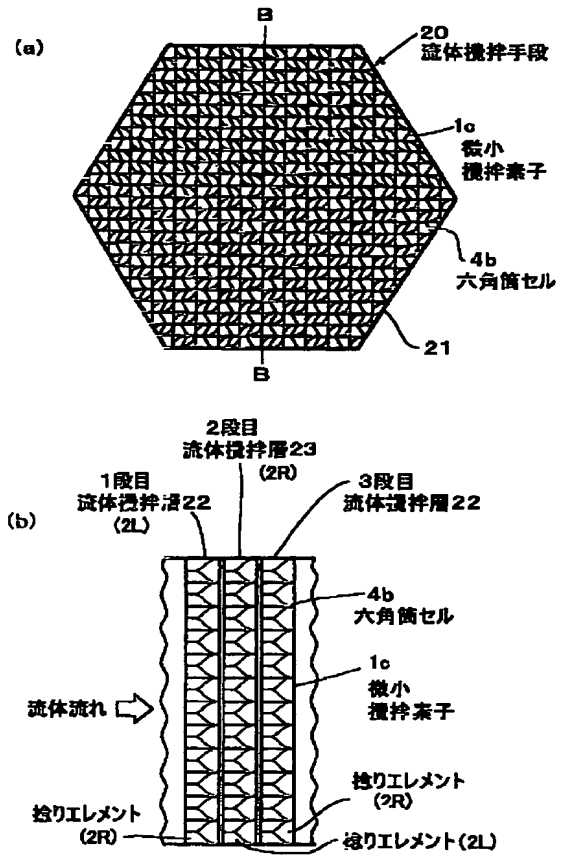
【図6】


25
28f
28e
28d
28c
28b
28a
26a
26b
27a
26
27b
27c
28

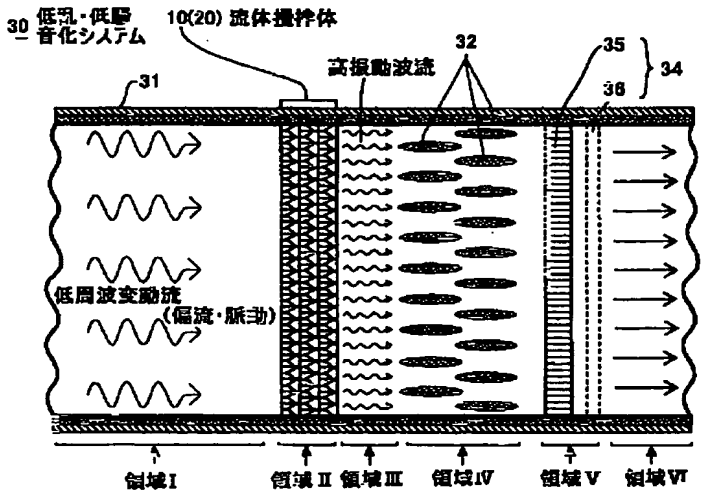
【図11】


60 空調システム
65
10(20)
流体
攪拌体
65
62
63
64
61

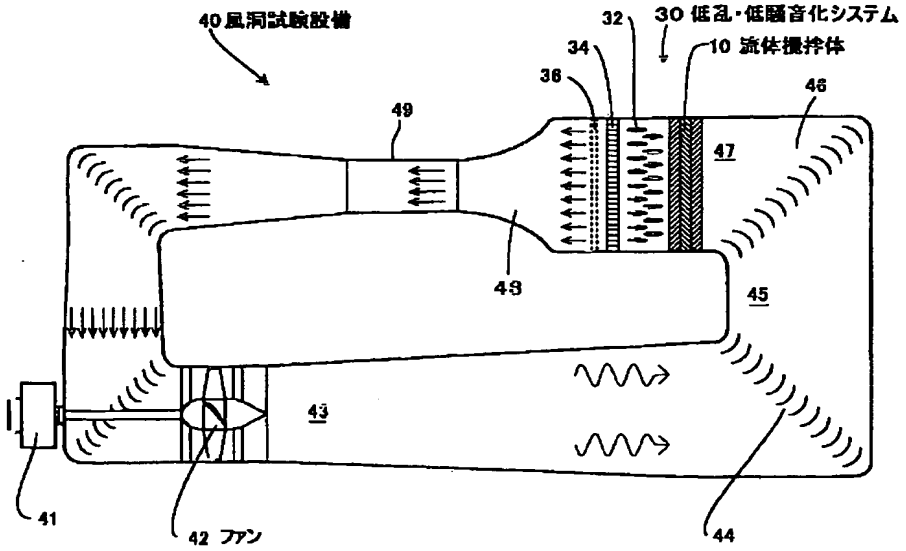
【図4】


(a)
B
20
流体攪拌手段
1c
微小
攪拌素子
4b
六角筒セル
21
B
(b)
2段目
流体攪拌層23
(2R)
1段目
流体攪拌層22
(2L)
3段目
流体攪拌層22
4b
六角筒セル
1c
微小
攪拌素子
流体流れ
捻りエレメント
(2R)
捻りエレメント
(2R)
捻りエレメント(2L)

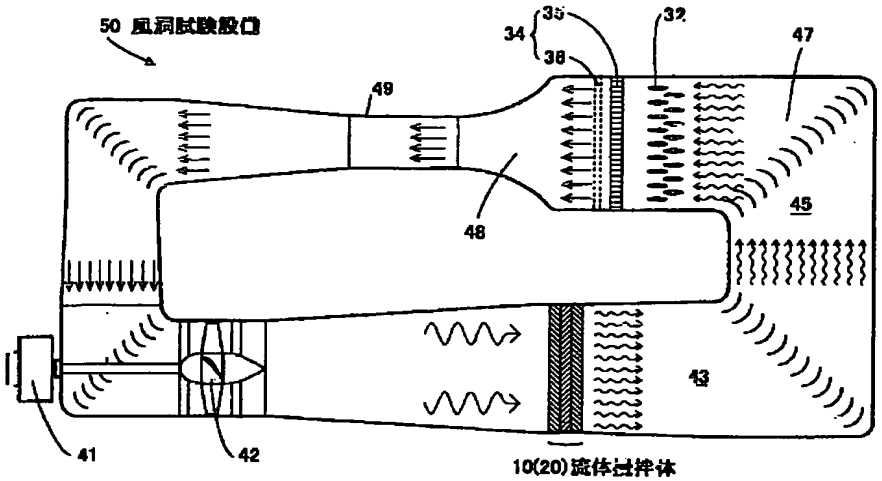
【図7】


30 低乱・低騒音化システム
10(20) 流体攪拌体
高振動波流
32
35
34
31
36
低周波変動流
(偏流・脈動)
領域I
領域II
領域III
領域IV
領域V
領域VI

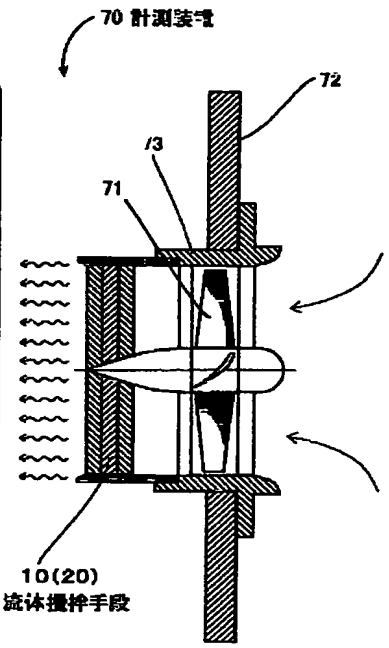
【図9】


40 風洞試験設備
32
30 低乱・低騒音化システム
34
10 流体攪拌体
36
46
49
47
48
45
43
41
42 ファン
44

【図10】



【図12】



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